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GEOGRAPHICAL REVIEW

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OUR CONTRIBUTORS

Dr. Bain is secretary of the American Institute of Mining and Metallurgical Engineers and a recognized authority on problems of mineral resources. His important study of "Ores and Industry in the Far East" (1927) was selected by the Council on Foreign Relations as the first of its Research Publications.

Mr. Munday is a member of the British Columbia Mountaineering Club and of the Alpine Club of Canada. He has explored a greater area of the Coast Range of British Columbia than any other climber, his later work in the region having been done in conjunction with his wife.

Mr. Ricketson is in charge of the excavations now being carried out at Uaxactun, Guatemala, by the Carnegie Institution of Washington, for whom he has worked since 1921. His work has taken him across the peninsula of Yucatan from Belize to Frontera, up the east coast to Tulum, and into the Petén District six times. During 1924 he excavated at Baking Pot, British Honduras, and in 1925 was at Chichen Itza, Yucatan. He has also worked in the Southwest for the National Geographic Society and for the Peabody Museum of Harvard University.

Professor Jefferson is professor of geography at the State Normal College, Ypsilanti, Mich. His varied geographical studies include especially investigations into population distribution and climatology in its human aspects. Among his writings are "Principles of Geography" (1926); "Man in Europe" (1924 and 1926); and in the *American Geographical Society's Research Series*, "Recent Colonization in Chile" and "The Rainfall of Chile" (1921), and "Peopling the Argentine Pampa" (1926).

Dr. Bigelow is research curator of zoölogy of the Museum of Comparative Zoölogy, Cambridge, Mass. He is chairman of the North American Committee on Fisheries Investigations and scientific advisor to the International Ice Patrol. For many years he has been engaged in an oceanographic and biologic survey of the Gulf of Maine, a memoir on which has recently appeared as Vol. 40 of the *Bulletin of the Bureau of Fisheries.*

Dr. Blanchard is professor of geography in the University of Illinois. He is the author of several local studies and is now working on a series of papers in the economic geography of Europe, based in part on field work.

Dr. Dixey is government geologist to the Nyasaland Protectorate. He previously held a similar position in Sierra Leone. In both countries his work has included physiographic and economic investigations. "The Physiography of Sierra Leone" appeared in the *Geographical Journal*, Vol. 60, 1922. To the *Geographical Review* he contributed "The Mlanje Mountains of Nyasaland" (October, 1927).

Dr. Wolfe is professor of economics in the Ohio State University. He has studied population problems and taught courses dealing with population for many years. His recent writings in the field include "The Optimum Size of Population," in "Population Problems," edited by L. I. Dublin, 1926, and "Is There a Biological Law of Population Growth?", *Quarterly Journal of Economics*, August, 1927.

Mr. Fisher is principal of the American Boys' School, Hamadan, Persia, the Ecbatana of ancient times.

Miss Warthin is a member of the staff of the American Geographical Society.

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The Leardo Map of the World of 1452 or 1453. Colored reproduction (measuring 28⅝ x 23½ inches, printed on sheet 35 x 30 inches) of map in the collections of the American Geographical Society. Accompanied by volume containing text by JOHN KIRTLAND WRIGHT describing the original map and a note by A. B. HOEN on the method of reproduction, with 3 photographs and 7 maps, viii and 90 pp. *Library Series No. 4.* 1927. $15.00 ($2.00 for text alone).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XVIII APRIL, 1928 NO. 2

THE THIRD KINGDOM

SOME REFLECTIONS ON OUR MINERAL HERITAGE

H. Foster Bain

MAN and the earth on which he lives have been the subject of study by geographers since the science of geography began, but heretofore attention has been concentrated mainly upon the earth as a surface over which man roams, a platform or stage upon which he acts his rôle. Far less consideration has been given to the earth beneath, the materials out of which it is made, the character, qualities, and distribution below the surface of these materials, all of which enter into and condition man's life and development, mightily so in these modern days. In discussing the materials with which he has worked the plant and animal kingdoms have received the major attention, but there are signs that the third kingdom is coming into its own.[1] In the words of Professor C. K. Leith addressing the Royal Institute on International Affairs a short time ago:

> Mineral resources constitute a factor in our physical environment which is being rapidly brought into prominence by the multiplying demand and the growing dependence of modern civilisation upon mineral resources. Up to comparatively recent times this environmental factor was regarded as of only incidental importance. It now figures largely in the consciousness of nations.[2]

The plant and animal kingdoms yield man many things essential to his life and happiness, but these are ephemeral. The world feeds itself from year to year on food produced mainly within twelve months of the eating. Continuous supply and continuous consumption go on together, and an accumulated stock of food for a long future is

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[1] Compare the opening pages of Shaler's "Man and the Earth" and the exceptional treatment accorded minerals in Brunhes' "La géographie humaine."

[2] C. K. Leith: Mineral Resources in Certain International Relations, *Journ. Royal Inst. of Internatl. Affairs*, Vol. 5, 1926, pp. 154–159.

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unthinkable. Past ages have handed down to us no food, only knowledge of foods. So, too, largely of clothing. The whole stock of cloth and leather we have inherited from the past would not clothe one small nation today.

Compare the mineral kingdom: go to any great museum, housed, as it happens, in a steel and stone structure with tile floors, glass windows, and metal plumbing, heated and lighted by burning coal, a structure built to last decades and probably centuries; in such a building you may see the actual marble statues that once stood in Athens and touch the coins that circulated in Rome or Carthage. The arms of early Japan, ornaments and household utensils of Chinese who lived dim centuries ago, relics of other peoples and civilizations of the long past are all there; and all of them that is preserved for us is the part that is wrought in or on minerals. The ideas and philosophy of the past we have only in part. How dark the history of Babylonia without her cuneiform tablets: what a ray of light was shed by a single Egyptian stele! Writings on paper and parchment have left us comparatively scant record, and a large part of it has come down through the ages only because copied and recopied, with how much loss and emendation scholars can never be quite certain. Our tangible heritage of the long past is almost exclusively in the form of mineral products, and we inherit so little from the ages because early peoples used minerals so sparingly.

What we pass on to the future of goods will necessarily be also in minerals. Today, the accumulated wealth of mankind is almost entirely in that form. Food is eaten or decays, cloth wears out or rots, wood remains serviceable but a few years; but roads, bridges, and buildings of stone, brick, cement, or steel are usable for centuries. Service is still held regularly in great stone cathedrals built in the Middle Ages; and parts of the old Imperial roads of China along which Marco Polo rode, bridges he crossed seven hundred years ago, are still in daily use.

The Indefinitely Increasing Demand on the Mineral Kingdom

The present is a world period of great prosperity and wealth. Man is richer than ever before in history, and the more "civilized" he is the richer he is. The more he has conquered nature and set her to work the more she has rewarded him. He eats perhaps little more than in the past but more surely and more regularly, and he enjoys greater variety. Beyond what he can consume a surplus of food means nothing to a man, whatever trading value it may have to an individual or nation. There is an easily reached limit beyond which no man consumes food, and problems of food supply are less important now than before minerals gave man command over distance. Mark Jefferson was right when he pointed out[3] that the mechanical and industrial age had relegated food to a subordinate place among the objects for which men labor. "Hunger," he said, "has become rare in the world. It is difficult for it to survive the glare of publicity, in the abundant stores of food and the speed of transportation."[4]

A limit, too, exists as to the amount of clothing that may be worn. Quantitatively a saturation point for textiles is easily to be foreseen. After that quality and style competition alone remain, and in Western Europe and America we already are well along in that stage. The hope of the cotton weavers for increased demand rests in the proverbial lengthening of the Chinaman's shirt tail. They already are losing ground to silk and rayon, and the corduroy weavers were saved from extinction only by the demand for upholstery in automobiles.

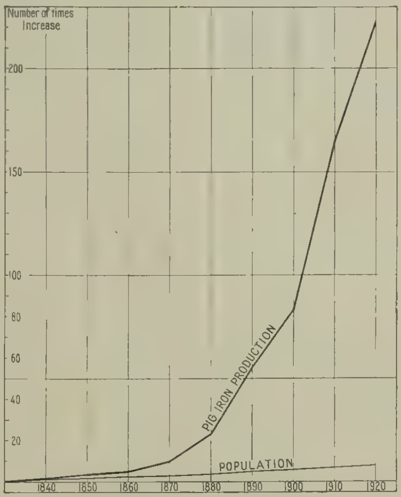

Fig. 1—Increase of pig iron production and of population in the United States between 1840 and 1920.

When, however, one turns to other of man's wants—housing, transportation, tools, and goods in general—there is no known limit, and the great economic discovery of the century has been the fact that increased consumption of all these can be stimulated, so far as we now know, almost indefinitely. Consumption of such goods is limited only by desire and purchasing power. The former can be roused while the latter increases *pari passu* with consumption through distribution of increased wages and dividends. For present discussion the significant fact is that production of all these goods is mainly dependent upon minerals either in the form of raw materials, as fuels, or as tools; and fuels and tools are equally essential to large production of food and clothing. There is no known limit to the demand we may come to make on the mineral kingdom, and the increased demand is not measured by mere growth of population. Per capita consumption of minerals in the Western countries through the last half century has increased at a rate which when plotted resembles a mountain slope, while the population curve is rather that of the playa before the mountains (Fig. 1). No longer is life so simple, so dependent on grass and moving herds, so free from impedimenta that whole peoples may, as did the Mongols, sweep a quarter of the way around the world. Think, by way of contrast, what a task it would be now to move the German nation, with its mines, mills, smelters, railways, buildings, and all its material equipment into Mongolia. It would clearly be impossible, nor does Mongolia contain the resources to sustain such a civilization even if by miracle the people were planted there. Modern peoples are molded by their environment as were ancient peoples; but new factors have come in, and of these the most important is their necessity for enormous quantities of minerals.

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[3] Mark Jefferson: Looking Back at Malthus, *Geogr. Rev.*, Vol. 15, 1925, pp. 177–189; reference on p. 184.

[4] *Ibid.*, p. 186.

Long after man discovered the value of minerals he used them but sparingly. N. S. Shaler estimated that as late as 1600 "there were only about twenty substances, other than precious stones, for which they looked to the underground realm. Clays for the potter and bricklayer, whetstones and millstones; iron, copper, tin, gold, silver, lead, sand for glass, mica, coal, peat, salt, and mercury make up all the important elements of this list."[5]

It was not until steam was put to work that there arose the need for metals and other minerals in quantity. As late as 1820 the people of the United States used, annually per capita, but five pounds of iron—the most common and necessary metal. A century later it required 597 pounds to satisfy their wants, and three years later 809 pounds. A like story could be told of other metals and minerals. Our use has shot up at an increasing rate until, as C. K. Leith has well said, "The world has used more of its mineral resources in the last twenty years than in all preceding time, and there is nothing to indicate a slackening of the acceleration which has occurred during this period. The production of oil, for example, is now as great for one year as for any ten years preceding 1900. . . . The last twenty-five years has seen as much gold production as the four hundred years following the discovery of America."[6] And again, "Here in the United States the per capita consumption of minerals has multiplied ten times in only forty years."[7] Such facts as to consumption lead naturally to questions of supply and distribution.

THE ENERGY-GIVING MINERALS

George Otis Smith, Director of the U. S. Geological Survey, has pointed out that "the broadest classification of natural resources is that of energy resources and industry's raw materials," and the same classification can be made specifically of the mineral resources, fuels being the world's greatest sources of energy. Continuing,

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[5] N. S. Shaler: Man and the Earth, New York, 1912, p. 5.

[6] C. K. Leith: The Political Control of Mineral Resources, *Foreign Affairs*, Vol. 3, 1925, pp. 541–555; reference on p. 541.

[7] International Control of Minerals, New York, 1925, p. 9.

Dr. Smith says: "Both in the quantity of power now used and in the energy stored up for future use the United States is preëminent. This abundance of mechanical energy, with which to lengthen and strengthen the arm of human labor, both increases the demand for industrial raw materials and increases our supply of metals, for instance, through reducing the mining and metallurgical costs. Herein lies the greatest stimulus to inventive genius, and the result is to make us not only greater consumers but greater producers. The net effect on our self-sufficiency in raw materials cannot be predicted. It is this sufficiency in power that makes America's future seem bright."[8]

It is the energy-giving minerals, coal and petroleum, that stand first in the service of mankind. Before modern times most of man's work was done by himself, his work animals, and his slaves. The Greek and Roman civilizations rested on slave labor. In Athens, at the time of her maximum glory, there were four slaves for each citizen, who furthermore drew a dividend from the state-owned silver mines at Larium instead of paying taxes. No wonder the voters could sit around in the shade of the temple groves and talk philosophy! In Rome the slaves won by war greatly outnumbered the citizens and left Romans free to fight. In later years, water power was developed and drove the slaves out of the bakeries, irrigation works, and the sawing of marble. Over the world as a whole but a few of the minor waterfalls were put to work until after steam came to be widely used and metals abundant. Even now less than 5 per cent of the power used in the United States comes from waterfalls, and if all the available power known were developed it would equal but one-fourteenth of our present total installed capacity. The wind never was used largely, save on the sea, and now yields us about one-tenth of one per cent of our power. The men and animals who for long centuries did the world's work had to be fed, sheltered, and persuaded or forced to work. This is no longer true. In steam and electricity man has found tireless, unsleeping, and powerful helps and ones which make no demand on his food supply. Only a part of the mechanical energy used by man is converted into electricity, but a memorandum from the Department of the Interior lately issued says: "The estimated output of nearly 80,000,000,000 kilowatt-hours of electric power for the United States in 1927, if it could be converted into equivalent man power, would provide the average family of about four persons in the United States with the services of eleven able-bodied mechanical laborers working eight hours daily, including Sundays and holidays, at a total cost for the eleven of about $75 a year." To these invisible slaves must be added those

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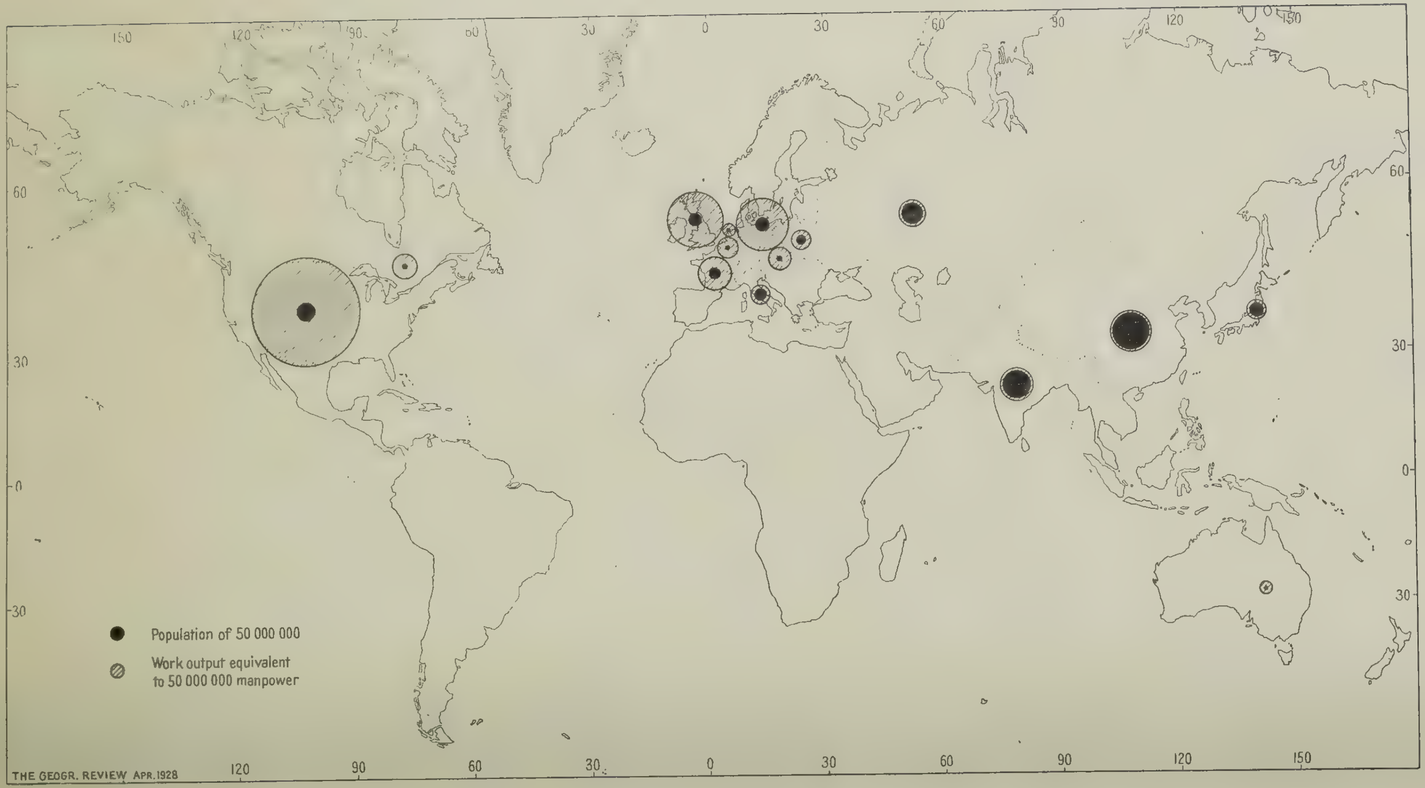
[8] G. O. Smith: Theory and Practice of National Self-Sufficiency in Raw Materials, in "Raw Materials and Their Effect upon International Relations," *Internatl. Conciliation No. 226*, January, 1927, pp. 7–13; reference on pp. 10–11.


150
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Population of 50 000 000
Work output equivalent to 50 000 000 manpower
THE GEOGR. REVIEW APR. 1928

FIG. 2—Cartogram showing population and work output for certain countries. Compare Table I.

which come direct from steam engines. It is because of these power genii that the work output of the world and the consequent consumption and production of goods increase at a faster rate than food supply and wealth per capita pile up.

Table I—Population and Work Output*

(Figures in thousands, 000 being omitted)

Country	Population	Work Output
United States	105,711	3,805,596
United Kingdom	44,169	1,060,056
Germany	59,853	897,795
China	427,679	513,214
British India	247,003	345,804
France	39,210	341,127
Russia	142,038	213,057
Canada	8,788	193,336
Czechoslovakia	13,611	156,526
Belgium	7,466	141,854
Japan	55,963	123,118
Italy	38,901	120,593
Poland	27,558	115,743
Australia	5,436	54,360
Holland	6,865	51,487

*Population figures for the year 1921; work output on the basis of population plus equivalent man power produced from water power and fuel, stated in terms of man days per year including human and mechanical work as recalculated from estimates by T. T. Read.

Human Labor Versus Mechanical Energy

Just how little of the world's work is now done by human hands is seldom appreciated. Thomas T. Read has brought together figures[9] to illustrate the difference between the work done in various countries and the number of people who live there. Any such figures are necessarily approximate, and the detailed results will vary somewhat with specific assumptions of equivalence chosen; but, remembering that two pounds of coal properly utilized will do the work of one man per day and that as actually used in steam-making three and a half barrels of oil consumed equal one ton of coal, and taking into account the developed water power in each country, figures that are at least of the right general order and proportion may be derived. Table I for the leading countries is based upon population figures for 1921 and Mr. Read's estimates of work output. From these figures it will be seen that countries are powerful not in proportion to population but in proportion to work. British India, for example, with 247,003,000 people exerts but a minor fraction of the force that

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[9] T. T. Read: The World's Output of Work, *Mechanical Engineering*, Vol. 48, 1926, pp. 531–532.

France does with 39,210,000. China with four times the population of the United States has less than one-seventh the power. Russia, with two and one-third times as many people as Germany, does less than one-fourth as much work. It is work that makes wealth and power today. With nearly the same population France does almost three times the work of Italy because her resources are superior. A much clearer picture of the strength of the various peoples may be obtained if these facts be reduced to a map like Figure 2 than if areas and population be charted.

Just what this application of mechanical energy to supplement human labor means may be made clear by a few illustrations from the field of transportation.

THE COST OF PRIMITIVE TRANSPORTATION METHODS

In unsettled parts of Africa transportation of goods is by carrier, the men marching along in single file with packages of goods on their heads. In parts where the white man's peace has not penetrated, and but a few years ago much of the continent was outside such limits, security of possession of property is so slight that a surplus of food sufficient for any considerable number of visitors to a village is not to be depended upon. It was formerly necessary, and still is in part, for caravans to convey their own food. But a man carries only 55 to 60 pounds and eats 2 pounds each day. Clearly he can go forward but 15 days, say two weeks, and have enough food to get back alive. Or two men may go forward one week and deposit enough food to enable a third to go two weeks farther. For every long journey into the interior it was formerly necessary to maintain an extensive carrier service unless, like Sherman, the explorer determined to live on the country, when he usually came to disaster. In 1902 when J. R. Farrell studied the copper deposits of the Katanga district in what is now the Belgian Congo, he was the apex of a pyramid of carriers numbering about 5000 and extending back through Bulawayo to the East Coast. Even so he had always to move quickly and sharply limit his stay in any one region because of possible food shortage. Contrast this situation with that in the same region now served by a railway. Great mills and a smelter turn out enough copper to threaten the balance of the world's trade in that metal. Elisabethville, the provincial capital, has all the comforts and luxuries of modern life; and as one drives out by motor car for tea and tennis in the afternoon or dines at its comfortable club in the evening, one realizes what minerals have both led men to do and also permitted him to accomplish in the far-off parts of the world.

Again contrast Major G. St. J. Orde Browne's recent report[10] on

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[10] *British Colonial Repts. No. 19*, London, 1926, p. 37.

"Labour in the Tanganyika Territory" in which is discussed the "almost incredible" wastage entailed by the porter system of transport.

> As an illustration of the amount of labour absorbed in this form of employment may be cited the figures for the station of Kilosa; during the year 1924, porterage for Government loads alone accounted for 400,000 working days, i. e. the entire labour force of a considerable plantation. In addition to this, there were probably even larger numbers engaged by private employers, since the economic development of the country still largely depends upon head porterage. The above is a good example since it has been possible this year to introduce motor transport from Kilosa to Iringa, with the result that the former figure has already been largely reduced.

In China man's first great mechanical invention, the wheelbarrow, is still used largely for transportation, mainly for freight but occasionally for passengers as when the women workers in the textile mills at Shanghai ride to work in parties of eight back to back as in an Irish jaunting car. A wheelbarrow, if handled by one man, will carry ordinarily 250 pounds, but the load may be increased for short distances to 400 pounds. The cost of transport is high despite the low standard of living of the barrowman. It works out to 15 or 20 cents gold per ton mile, and the limitations of such transport are close. In famine times food has been carried 70 miles, but the effective limit worked out to much less. Unless some food is available en route, that used by the barrowman in going and coming cuts deeply into the load. A modern locomotive carrying 18 tons of coal and 15,000 gallons of water for its own use can haul a train a mile and a half at 40 miles an hour over one-per-cent grades. It does the work of 65,630 wheelbarrow collies and does it more rapidly and surely. A coolie delivering coal balls by the basket in Peking, say, carries about 65 pounds and goes about two miles in one hour, earning about 50 cents a day. A negro in Washington delivers coal by the truck load of seven and a half tons. He goes 12 to 14 miles per hour, works 8 hours, and receives more per hour than the Chinese does in a long day. He does the work of nearly 1400 coolies.

It is the same thing with water transportation. A type of canoe used on the rivers of Colombia carries 4000 pounds. Poled upstream it may make 8 miles per day, depending on current and depth of water: or it may make 40 miles downstream perhaps. A steamer of the Great Lakes carries 13,000 tons of coal and travels 10 miles per hour and is essentially independent of current. It would require 6500 canoes merely to carry the same tonnage regardless of rate of speed and delivery.

Minerals as an Incentive to Pioneering

The earliest form of ocean transport was by small wooden coast-following boats propelled by oars or leather sails. Their radius of action was short and their carrying capacity small. Even the Greek and Roman triremes with ten marines, twenty sailors, and one hundred and seventy rowers had but a short radius of action. By contrast the airplane carrier *Saratoga*, with more officers than the trireme had rowers, can go anywhere and has a power plant equivalent to that of 2,000,000 galley slaves. The trade of ancient days was conducted by small boats that kept close to shore on account of the need of food and water as well as because of difficulties in navigation. Transport was expensive. Hence, the most compact goods or those that were most valuable by reason of their scarcity were favored in this early trade. The Frieslanders brought to England furs and amber from the Baltic and took away gold from the Irish mines and tin from Cornwall. It was tin apparently that drew the Phoenicians, and later the Romans, to Britain, and gold that lured the *conquistadores* across the weary miles of North and South America; and indeed mines have ever been a most powerful incentive to exploration and trade.

The diamonds of Kimberley and the gold of the Witwatersrand brought the railroads and cities of the white man at one leap into the heart of the black continent and thereby precipitated conflicts of race, of ideas, and of economics all at once. Before metals were used in quantity and railways were built, such a sudden jump of the frontier would have been impossible. Penetration was necessarily slow and by stages. Men's minds as well as roads had to be prepared; and the slowly built bridges of acquaintance were extended across the gulf between peoples instead of quickly thrown bridges of steel across the rivers. The whole method of frontier conquest has been changed by the new servants won by man, and the problems of human contacts that have resulted are as severe as problems of food supply and of raw materials. The rate at which copper can be produced in Katanga is largely determined by the rate at which the necessary labor can be collected and converted from primitive habits of life and simple communism into individual workers motivated by a desire for things previously outside their range of hope of attainment or even knowledge.

Development of minerals not only complicates the problems of conquering the frontier by introducing a new element of speed, but the importance of the larger mineral deposits to modern industry and to national security introduces new motives of action. Disregard of the influences that flow from our mineral environment can only lead to international friction and from time to time to national disaster. It becomes vastly important to determine what are the special characteristics of mineral deposits that made them factors in the settlement of a country and in its political and commercial policies.

Problems in the Utilization of Mineral Wealth

Unfortunately, but little systematic study of these problems has been made. Before the World War the significance of minerals was little appreciated save by those engaged in their production. The producers had been so successful that manufacturers and users had come to expect a sufficient supply with no more personal responsibility for keeping it up than for maintaining the sunshine. It is true that in President Roosevelt's administration conservation began to be discussed; but attention was fixed more on timber supply and soils than on minerals, although even then it was coming to be seen that ore deposits are exhaustible and oil and coal deposits have a limit. So little, however, was the significance of these facts realized that taxation for years afterward was levied on minerals as on any other property and no account was taken of the fact that output inevitably represents depletion of capital.

It was only when the world realized that the war would be won not by number of men but by volume of materials, when sudden demand was created for quantities far beyond current production, and when serious scarcities appeared, that governments and peoples alike had it borne in on them beyond escape that minerals are not like other natural products, that they cannot be transplanted and raised at will, that no second crop will follow the first, and that while the energy-giving minerals are totally consumed in use, the metals and other minerals have a permanent value and in part may be used over and over. Just how large a factor re-use may become was not realized even by metal users until the scrap from battle fields and munition works after the war disorganized trade and shut down great plants designed for producing virgin metal. As late as three years after the war one large copper smelter in the United States was restricting ore purchases in order to re-melt a supply of new copper tubing bought as junk. Such maladjustments exact a heavy price from industry. The relation of man to minerals would seem to be as important as to climate.

Probably the most comprehensive studies of these problems that have been made were those undertaken by the Committee of the Mining and Metallurgical Society of America on Domestic and Foreign Mineral Policy, and of the American Institute of Mining and Metallurgical Engineers on Industrial Preparedness. It was only last August that Sir Thomas Holland, at the opening session of the British Empire Mining and Metallurgical Congress in Montreal made the plea that led that body to decide to take up similar studies. Earlier there were the reports of the International Geological Congress on iron ores[11] and on coal,[12] though these were inventories of reserves rather than broad studies of the relations of man and his activities to minerals. A number of individual books also have been printed that bear on or fringe the subject, such as those of J. E. Spurr[13] and George Otis Smith,[14] and a considerable number of interesting individual magazine articles have appeared, several in *Foreign Affairs*, for instance. It has engaged the attention of the Council on Foreign Relations.[15] The whole matter was the subject of one study group at the Institute of Politics, Williamstown, Mass., in 1925 and 1926, and there have been numerous evidences of an awakening interest.

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[11] The Iron Ore Resources of the World: An Inquiry Made upon the Initiative of the Executive Committee of the XI International Geological Congress, Stockholm, 1910, 2 vols., Stockholm, 1910.

The studies of the American Institute of Mining and Metallurgical Engineers and of the Mining and Metallurgical Society of America already mentioned, which studies, as it happens, have been reprinted in a single booklet,[16] come most nearly to giving a comprehensive review of the subject. Even so they were directed mainly at the problem of supply as an element in national defense and leave much unsaid about minerals from other points of view. Drawing, however, largely upon this report, the following general summary may be made of the more significant facts as to minerals.

Minerals a Limited Resource

Unlike the products of the animal and plant kingdoms, minerals are not reproducible. Whatever of them we are to have is already here in the earth under our feet. There is no known way of increasing the quantity or renewing a supply once exhausted. One crop, and one crop only, exists. Water running down from the mountains to the sea and turning perhaps a dozen power wheels en route may be evaporated by the sun's heat, travel as clouds to the mountains, fall as rain, and go down a second time or any number of times to the sea. Coal, however, burned under a boiler gives up all its energy in one burning. The gas and ashes into which it changes have no more energy to yield. A pine forest, logged off, may be succeeded quickly by maples or other hardwood trees under whose protecting shade a second pine forest may get a start; but an iron mine once worked out has no more ore to give. The fields of southwestern Missouri and adjacent parts of Kansas and Oklahoma have yielded crop after crop of grain or fruit for many years and may continue to do so indefinitely; but one may wander among the piles of waste and tailings, note the abandoned shafts, plot the shift of mining activity to the Southwest as the years have passed, and find abundant proof that the zinc and lead beneath the fields can be mined but once. The total amount of mineral available to man is fixed. It is a definite reserve against which he issues drafts.

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[12] The Coal Resources of the World: An Inquiry Made upon the Initiative of the Executive Committee of the XII International Geological Congress, Canada, 1913, 3 vols., Toronto, 1913.

[13] J. E. Spurr, edit.: Political and Commercial Geology and the World's Mineral Resources: A Series of Studies by Specialists, New York, 1920.

[14] G. O. Smith, edit.: The Strategy of Minerals, New York, 1919.

[15] The first of the Council's Research Publications (1927) is "Ores and Industry in the Far East," by H. Foster Bain, briefly reviewed in the *Geogr. Rev.*, Vol. 17, 1927, p. 517.

[16] International Control of Minerals, New York, 1925.

A certain modification of this statement must, however, be noticed. While the total present is fixed, the amount available for use from time to time varies. It happens that most useful minerals occur in many degrees of mixture with those of little or no use. Production requires the separation of the useful from the non-useful; and fortunately technology, methods of organization and management, the tools of industry, and the capital available for use all improve or increase as the years go by so that it becomes possible progressively to work bodies of ore that contain smaller and smaller proportions of the useful minerals or metals. Today a third of our great copper production is won from rock that contains so little of the metal that twenty years ago it was not considered worth taking into account. For the same or similar reasons man is able as necessity arises to go deeper and deeper into the earth and mines 6000 feet deep are now profitably operated on the Rand even though gold exchanges for less in other goods than when gold mines were but a few hundred feet deep. Oil wells more than a mile deep are now not uncommon, though it was only in 1859 that the Drake well with a depth of only 67 feet started the modern petroleum industry. These and similar victories over nature have been won because of the power of men's minds, and in that power lies the best assurance that even the constantly growing demand for minerals will somehow be met.

One may properly have great faith in man's power to solve his difficulties as they arise, and yet one may hold that it is advisable to avoid such difficulties if possible and to take full account of them in any event. An exhaustible resource is clearly one for special treatment. If this country were told that after a fixed period no more wheat could be grown within its limits, definite steps would be taken to make ready for that contingency. When it was shown that if unchecked the boll weevil would within a limited number of years destroy cotton farming, there was no limit to the men and money made available to find a way to prevent such a disaster. But hydraulic gold mining has stopped; gold dredging has nearly ceased; and gold mining itself is a dying industry. Whole areas have been deserted because of the decay of silver mining; the natural gas belt of Indiana is but a lurid memory of waste. Yet when one suggests the possibility of the exhaustion of our oil fields or the advisability of permitting such organization of the coal industry as will prevent four tons being wasted to mine six, he is apt to be called an alarmist and certain to be considered a nuisance. A people who hold within the limits of their country great mineral resources are trustees of an asset that belongs to the world and in which posterity as well as the present may rightly claim a share; and they are charged with responsibility for thoughtful consideration in its development and use.

The Irregular Distribution of Mineral Deposits

Mineral deposits are irregularly distributed over the world. Nature has scattered her favors unequally. The Lake Superior region is characterized by great deposits of copper and iron, but it would be useless to look there for coal. Coal occurs in abundance in Illinois and in Western Pennsylvania; but in neither does copper occur, nor is iron present in significant amounts. Gold is not found in Iowa nor, so far as known, petroleum in Nevada. Antimony is not mined in Florida, nor phosphate rock in more than most meager amounts in China. If one of China's antimony mines could be moved to Florida in exchange for a few square miles of phosphate rock, each country would gain greatly thereby. The Federated Malay States contain only one mine of low-grade coal, but they dominate the world in tin production. The United States contains hundreds of coal mines and the world's largest coal reserve, but no amount of oratory or tariff assistance will put tin in the rocks of our mountains where nature has not formed it. If all of us are to enjoy the bounties of nature even in a minor degree it is clear there must be an exchange of minerals and metals. International trade in minerals and metals is a trade that cannot be blotted out. It is possible to transplant rubber from Brazil to Malaya, but it is not possible to move Brazil's manganese to the United States save ton by ton. We make in this country some 40,000,000 tons of steel per year. For each ton we need about fourteen pounds of manganese, and unless we learn ways of using much lower grades of ore than are now employed in manufacture we must continue to import high-grade ore or ferro-alloys. In this instance we have some choice of whom to deal with, since Russia, India, West Africa, and Brazil all contain large deposits of favorable grade. In the case of other metals it frequently happens that less choice is open. Canada dominates the nickel supply of the world. Canada and Belgium divide the world's market for cobalt equally between them. Malaya, Netherlands East Indies, and Bolivia furnish most of the tin, with Siam, China, and Nigeria supplying minor amounts. The United States and Italy provide the world with its sulphur and meet only the competition of pyrite burners, the Rio Tinto region of Spain furnishing the major supply. Italy, since the war, dominates the mercury market, although Spain has the richest mine. So high have prices been set for this minor but essential metal that mines in the western United States find it profitable to work ores containing as little as four pounds of mercury in a ton of rock. Everywhere the distribution of minerals is unequal, and the demand is even less well adjusted since the centers of industry are fixed by a combination of factors among which the presence of coal and iron are dominant. In general terms the other minerals flow to the areas where these are to be had, and surplus goods go back in payment.

Use and Value

Differences in properties, uses, availability, and consequently value enter into fixing the lines of trade in minerals. Some minerals have a limited field of usefulness but are none the less almost indispensable. Platinum and mercury may be cited. No large use is known for either, but where they are needed the need is so great that a high price per ounce and per pound respectively does not prevent their employment. Tin is in a slightly different category. If it were cheaper it would be more widely used. Even as things are, substitution is practiced wherever feasible to the benefit of lead, cadmium, and aluminum. Where tin is essential or so much better than anything else as to be virtually so, as in food containers, the amount used is so small a portion of the package sold that a rise in price from 30 to 70 cents a pound makes no difference to the ultimate purchaser of say a can of tomatoes and so is no bar to its continued use. These are minerals which are produced and sold by the ounce or the pound. They illustrate a class of which it is true that production at a distance is no bar to general use because the amount of transportation required is small. It is the same phenomenon as the sale on the Pacific Coast of a garment made in New York at a less price than in the city of origin, the freight on the light weight amounting to less than the difference in rental of selling space. With bulky minerals the situation is different.

Iron ore is rarely shipped long distances save where cheap water transport is available, and all over the world iron ore moves to the coal fields to be made into steel rather than the reverse because coal is bulkier and because coal fields beget industry and industry consumes steel. Save to a limited extent as back-flow freight, it does not pay to ship coal to iron-ore regions to make steel. One would need to reload the steel and ship it back to or near the coal fields in order to find dense consumption. It is the peculiar characteristic of coal that it gathers around or near it factories and industries by furnishing workers that do not eat, which makes it incomparably our most important mineral, truly the "mainspring of civilization" as Newberry once characterized it. Whether the much discussed project of burning the coal at the mines, generating electricity, and transmitting the latter to industrial centers will ever be effected on a large scale is doubtful. For one thing power-making requires quantities of water as well as coal, and for another the great cities are most of them not far from coal fields or at least within such distance that the available transportation does not more than double the mining cost of coal. For the ordinary American householder the price of his coal consists of three nearly equal parts, mining cost, transportation, profits and trading costs. The large industrial buyers manage to squeeze out most of the third item.

The correlation of coal fields and industry is not exact. Many exceptions can be found, and much coal is shipped long distances. Indeed, for many years England balanced her foreign trade by shipping coal around the world; but countries without coal are heavily handicapped in industrial competition and, as to war, are necessarily under bonds to keep the peace. A country having coal has something for sale for which there is a wide market; and even though it may not sell coal it has still the power with which to manufacture goods and so, even when raw materials must be largely bought abroad, may retain the profit due to manufacture. It has a special advantage in the so-called heavy industries, such as steel making, metal production, and tool manufacture. What all this means may be seen in the contrast between France and Italy. It has already been pointed out that these countries have about the same population but that in France nearly three times as much work is done. France is now independent as to coal supplies, while Italy must import almost all that it uses. Ingenuity, skill, and hard work, no matter how faithfully they be applied, cannot altogether overcome the handicap of poverty of mineral resources. The intense industrial activity, the rapid rise in wealth, and the dominant position in world affairs held by North America and Western Europe are due to many causes; but among the most important have been the presence of and the will to use their abundant mineral resources, of which coal stands first. Petroleum has, in recent years, climbed rapidly to an importance long denied to it; but in the form of the crude oil from wells it is of only temporary importance, all the more as the demand climbs to millions of barrels a day. No serious student doubts that in a short period—short as world affairs go—the oil wells will drop to a secondary place and our main reliance for petroleum will again be coal as in early days; with shale oil to supplement it. Many of the industries that now depend upon crude oil burned under boilers for power will, without doubt, eventually return to burning coal. With the keenest appreciation of petroleum as an incomparable gift of nature we can hardly look to oil fields themselves as likely to determine permanent loci of industry.

It is obviously to the general economic good that minerals and metals, which seldom occur pure in nature, should be dressed and refined at the nearest feasible assembly point. It is better to ship copper from Chile than copper ore, if the amount available will feed a smelting plant of sufficient size to constitute an economic unit. This is true despite the necessity of importing oil for fuel. On the other hand, copper-bearing pyrite produced in northern Norway has been shipped to southern Sweden as ore because the copper, iron, and sulphur can all three be used to advantage there. In other situations where pure sulphur can be laid down cheaply its advantages in the smaller furnace capacity needed, in less deterioration when stocked, and in other particulars have operated to stop a previous flow to the region of iron pyrite. Pure materials can be shipped a long distance, but impure ones are best refined as near the source as may be, thus conserving transportation and giving to the country of origin the benefit of minimum manufacture at least.

Exploitation: Importance of the Large Mineral Deposit

It follows from what has been said that if the world is to continue to enjoy the civilization of the present and if the benefits of the latter are to be felt lower and lower in the social scale and to spread farther and farther into the backward countries, immense quantities of minerals must be dug out of the earth and set to work. A large portion of this material will necessarily be transported in the form of raw or semi-finished products from one place of origin to another, and goods made from these minerals or by their use will need to be shipped back or exchanged for still other goods. A great network of industry is inevitable, and it is equally certain that it must be international. No country is wholly independent as to mineral products. Our own is as rich as any; but our industries cannot now be sustained by the output of our mines only, great as that is, for the reason that in the case of numerous minor but essential minerals the deposits do not exist in the United States. Every country finds itself more or less in the same condition and so has an interest in maintaining the utmost permissible freedom as to exploration, development, and trade in minerals. A tariff to encourage sugar raising at home or to equalize costs of manufacturing between countries is understandable, but a tariff to promote mining a mineral that does not exist or is present only in insignificant amounts is absurd. A reasonable export tax, in countries where such taxes are legal, on any product shipped out of a country may be defensible as a matter of revenue production; but a restrictive tax to capitalize natural monopoly inevitably provokes retaliation. The best interests of the world are not so served.

No complete inventory of the world's mineral resources has been made. It is believed that the large outlines are known. Not all the coal, iron, copper, lead, or zinc deposits have been surveyed, but under modern conditions a large deposit can be developed and operated with so much greater economy than the same tonnage in a number of small ones that the large deposits as a class have a virtual monopoly. It is the same as in work. Merely to carry the load pulled by one modern locomotive would require 40,000 men and to transport the same number of tons in the same time would call for 2,220,000. Even small railroads buy locomotives fifty at a time, and it is clear that it would be out of the question to do by hand labor what the locomotive does. It is equally true that if we had to draw our 75,000,000 tons of iron ore each year from little deposits yielding even 100 tons a day, the service of supply would break down. In studying the possible development of a certain coal field in China from which at the time a trickle of coal came out by native boats, it became clear that there would not be surface enough on the river to accommodate enough native boats to transport the output of a modern colliery. The very size of modern industrial units makes some things possible and others impossible, and this is as true in the development of minerals as in other modern work. There are many reasons for believing that the large mineral belts of the world are already outlined.

Foreign Exploitation and National Sovereignty

A fear or jealousy crops up from time to time over development of mines by foreign capital—a feeling that in some way national sovereignty or proper political loyalty is impaired. Under any reasonable contract or system of regulations this is unwarranted. It is entirely possible, indeed it is now usual, so to conduct operations that benefits result both to the foreigner and the native citizen from converting a future into a present value. It is a fear hard to kill, however, and occasionally it is expressed even among such good friends as English, Canadians, and Americans. The sound point of view has been excellently set forth by Sir Robert Horne, speaking at the banquet of the Empire Council of Mining and Metallurgical Institutions in London November last:

> For my part I am glad to see American capital developing Canadian resources. It is much better that those resources should be developed than that they should remain in abeyance. I, of course, regret that more British capital is not available for the purpose, for the reason that the profits to be obtained from the use of the capital would come to Britain, and also because the supply of that capital would bring employment to this country, for all the money that goes out to another country from here goes ultimately in the form of goods. Therefore, I would rather see British capital invested in Canada than American, but I would rather see American capital invested than no capital at all. ["Hear, hear."] The real truth is that countries are not controlled by the capital which they bring in from the outside. We have got the most sinister example to the contrary in Russia, which employed vast amounts of capital from other countries, but had absolutely no concern for those who provided it when it came to political action. Government depends upon the

character and desires of the citizens, and I am confident that, whatever American capital may go into Canada, there will be no weakening of Canadian loyalty to the British throne.

Capital necessarily serves the country in which it labors and in no way does it serve better than in bringing in modern knowledge, machinery, and management to open up and set to work the minerals with which nature has endowed a land. To allow these to lie dormant in the earth is but to turn one's back on the modern world and return to the primitive living of our remote ancestors.

EXPLORATIONS IN THE COAST RANGE OF BRITISH COLUMBIA

W. A. Don Munday

THIS is the narrative of two expeditions in which Mystery Mountain (Mt. George Dawson)[1] was located and its altitude determined as over 13,200 feet, thus making it the culminating peak of British Columbia if Mt. Fairweather, 15,827 feet, which lies partly within the northern extremity of the province be excluded. Mystery Mountain is in the Coast Range 24 miles from tidewater. Even so late as 1925 the Chief Geographer of the province, describing its physiographic features, could say of the Coast Range that "apart from the lofty section at the northern limits of British Columbia . . . there are no known peaks as high as some of those of the Rocky Mountains."[2] In that year came the first confirmation of vague but persistent rumors of more lofty mountains. Dr. V. Dolmage, of the Geological Survey of Canada, reported peaks over 10,000 feet; and "one exceptional peak, judging by instrumental observations made on it from several triangulation stations, is over 13,000 feet."[3]

While the Canadian Rockies have claimed much attention, especially in the last 20 years, the Coast Range has been comparatively neglected. Many thousands of square miles remain unexplored, even within comparatively short distances of well established routes of travel of the past or present day. Yet this part of the country has much to offer both geographer and mountaineer. The great inlets of the sea "rival in their magnificence all examples of the fiord type in the world."[4] Inland is a striking scenery of narrow trenchlike valleys and jagged peaks piercing widespread glacial areas. Nowhere else on the North American continent south of Alaska are glacial features so extensively developed as between the Bella Coola and Toba

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[1] Since this was written the Geographic Board of Canada has given the name Mt. George Dawson, in memory of the eminent Canadian geologist and geographer whose name is also borne by the chief town in Yukon Territory and by the Dawson Range and Mt. Dawson in the Selkirk Range. Provincial authorities unsuccessfully urged the name "Mt. Waddington" in honor of a pioneer prominently associated with the adjoining territory. J. E. Umbach, Surveyor-General of British Columbia, informs the writer that he regards the mountain as the highest in British Columbia.

Most of the names used here have not been passed upon by the Geographic Board of Canada, but the majority have received the tentative approval of the British Columbia representative.

[2] G. G. Aitken: The Progress of Survey and Settlement in British Columbia, *Geogr. Rev.*, Vol. 15, 1925, pp. 399–410.

[3] V. Dolmage: Chilko Lake and Vicinity, British Columbia, *Canada Geol. Survey Summary Rept.*, 1924, Part A, pp. 59–75, Ottawa, 1925. The official triangulation by the Department of Lands of British Columbia is 13,260 feet.

[4] J. A. Bancroft: Geology of the Coast and Islands between the Strait of Georgia and Queen Charlotte Sound, B. C., *Canada Geol. Survey Memoir 23*, Ottawa, 1913, p. 20.

Rivers, in the midst of which region stands Mystery Mountain. A zone of glaciation of 5000 feet on 8000-foot peaks is commonplace, and nearly double this exists in several instances among the higher mountains. Mystery Glacier descends to within 500 feet of sea level six miles from tidewater. It is not improbable that at least one snowfield in this region will prove to be even larger than that of the Columbia Icefield, 110 square miles.[5]

First View of the Mountain, 1925

The writer's interest in the Mystery Mountain region took definite shape as the result of a trip to Mt. Arrowsmith in June, 1925. Although only 5976 feet high, Mt. Arrowsmith is the dominant massif of the southern half of Vancouver Island and offers a view which, in extensiveness and interest, is out of all proportion to its height.

In the wake of a severe snowstorm above the 3000-foot level, the atmosphere possessed the clarity usual before the summer's destructive forest fires begin. For 150 miles the Coast Range reared 8000 feet and more above the moat of the Strait of Georgia, its snowy battlements still decked with many cloudy banners of the passing storm. Almost due north we discovered amid the clouds the black bulk of a massive mountain, too rugged to be whitened by the storm and apparently the monarch of its district. It was readily picked out with the naked eye. In the light of the information then available this seemed likely to be Dr. Dolmage's big mountain.

In search of this unmapped mountain we sailed the following September on the coastal steamer *Chelohsin* to Orford Bay, a logging camp 15 miles up Bute Inlet and 160 miles from Vancouver. Here we met Jack McPhee, a trapper living the year round at the head of Bute Inlet which is 40 miles long. He told us of the semblance of a hunting trail extending through the timber of the lower slopes of Mt. Rodney, 7843 feet in height and distant about two miles from tidewater near the head of the inlet, and agreed to take us along in his boat. A combination of circumstances made the climb to timber line particularly trying. Weather proved inclement, but altogether three peaks were ascended, the main peak of Mt. Rodney leaving nothing to be desired as a viewpoint. In the four or five thousand square miles visible rose innumerable peaks, not a score of which are even named, while only the main rivers are mapped.

Merely from the standpoint of mountaineering difficulties, the group of eight and nine-thousand-foot mountains close to Mt. Rodney on the east side of Bute Inlet suffer little in comparison with any ordinary group of summits in the same latitude in the Rocky Moun-

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[5] Report of the Commission Appointed to Delimit the Boundary between the Provinces of Alberta and British Columbia, Part II, Ottawa, 1924, p. 62.

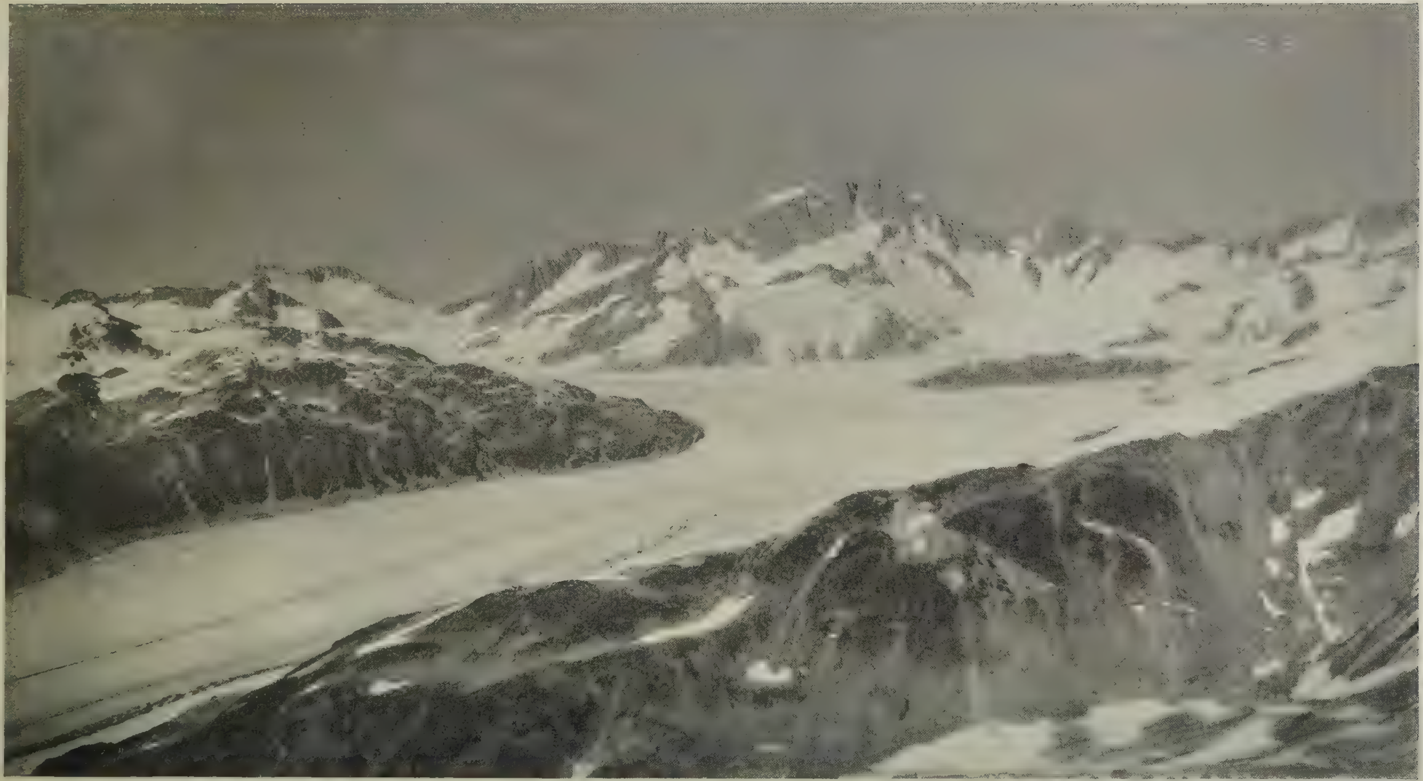

Fig. 1—Mystery Mountain (Mt. George Dawson), believed to be the highest peak of British Columbia. Mystery Mountain in center, Mt. Munday extreme right, Spearmen Peak between, Mystery Glacier in front.

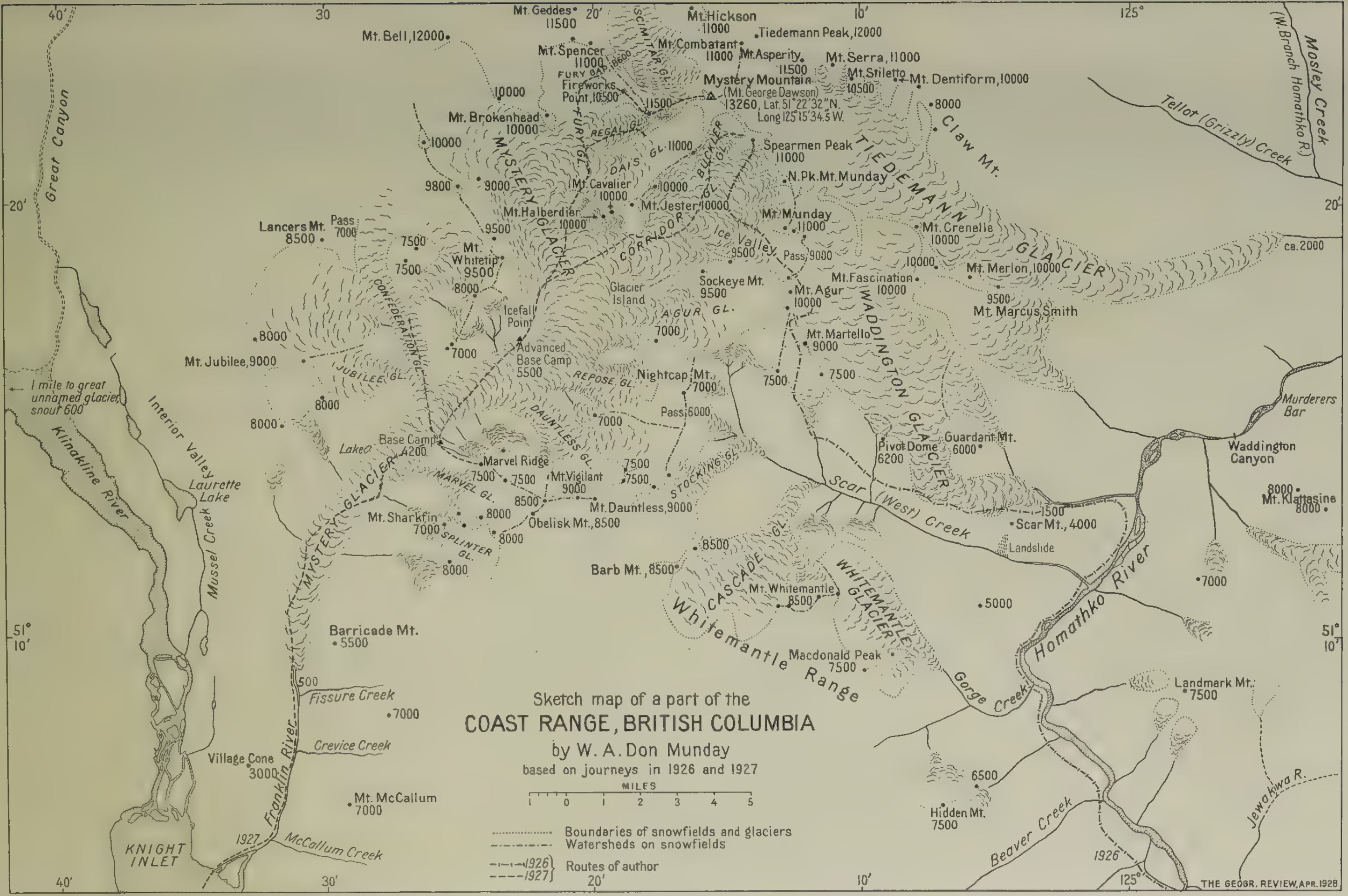

FIG. 2—Sketch map showing the routes of the 1926 and 1927 expeditions to Mystery Mountain (Mt. George Dawson). Scale approximately 1 : 300,000. Compare Figure 3.

tains. Mt. Massive, the mountain that had lured us forth, was still 30 miles away to the north. Its form strongly suggests that it is volcanic in character. But in spite of being fully 10,000 feet in height, it was now seen to be completely outranked in altitude by a lofty range to the west. These greater peaks rose in orderly succession westward, culminating in a giant of unchallenged supremacy. Wave-like ridges of seracs on the icefall of the S-shaped southern glacier of this group showed clearly, although 35 miles away up the Homathko River, the larger of the two rivers flowing into the head of Bute Inlet.

On our return from this preliminary trip we stood in some risk of missing the *Chelohsin* on her weekly call at Orford Bay because our friend McPhee had been severely assaulted and his boat and engine damaged by Indians. Fortunately for us, he was able to make his way to the only other white resident north of Orford Bay who came to our rescue—we were marooned on the precipitous shore of the inlet without fresh water. Indians passing in their fishing boats had declined to help us in any way, being hostile to all whites owing to determined efforts to compel them to obey essential fisheries regulations.

THE HOMATHKO VALLEY

As the estimated distance of the big mountain from tidewater did not exceed 45 or 50 miles, its exploration did not appear unduly formidable at first sight. But from long experience with trail-less valleys of the Coast Range we have learned that here distances are best measured in terms of hours and days. The Homathko valley, up which our route was to lie, has its source in the interior plateau near the headwaters of the Chilcotin tributary of the Fraser. It nearly became a main artery of travel to Central British Columbia. In 1863–1864 Alfred Waddington had under construction a toll road to the Cariboo gold fields. This project halted abruptly when Chilcotin Indians massacred his trail gangs without warning. The Chilcotin War followed, ending with the hanging of five of the murderers. But the disaster had practically bankrupted Waddington, and trail work was never resumed. The motives of the Indians were plunder and revenge. The Chilcotin tribe had been nearly wiped out by smallpox, said to have been spread by unprincipled white traders in 1862 by the plundering of Indian graves of infected blankets for sale to the Indians; these traders, it was said, threatened to bring back the scourge upon the remnant of the tribe.

Waddington's name is perpetuated by Waddington Canyon 30 miles from the mouth of the Homathko River, Waddington Channel near the mouth of Bute Inlet, and Waddington Harbor at the head of the inlet although it has little to commend it as a harbor. In 1874–1875 the Canadian Pacific Railway ran a reconnaissance line along the Homathko River; but naval advisers of the British and Canadian governments recommended choice of Burrard Inlet in preference to Bute Inlet as the Pacific terminus of Canada's first transcontinental railroad. Difficulties of travel in the Homathko valley brought one of these survey parties measurably near starvation.

Waddington optimistically described the river as "entirely navigable for river steamers for 36 miles," and a similar statement rashly incorporated in the British Columbia Pilot survived there for 50 years. For many years navigation was completely blocked by a log jam four miles from the mouth. Apart from this the river is full of obstructions, as we amply proved during our trips to bring in supplies for the season's work. In less than 30 miles it falls 525 feet. One trapper works along the river below the canyon for a few months in winter, but there is not a single settler in the valley. Several thousand acres of good agricultural land are barred from settlement by a government reserve across the mouth of the valley.

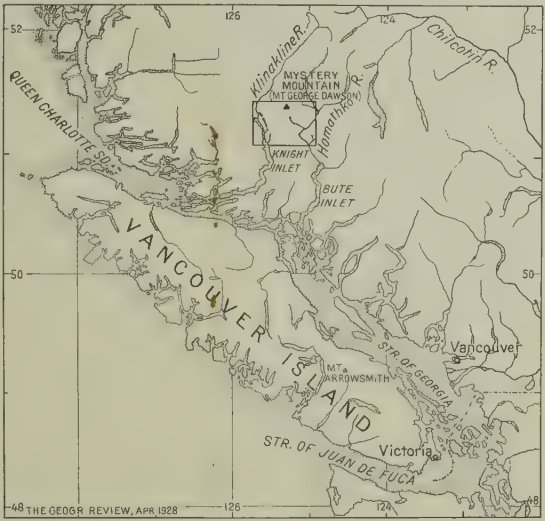

FIG. 3—Map showing the location of the Mystery Mountain (Mt. George Dawson) region. Scale 1 : 7,000,000.

EXPEDITION OF 1926: UP THE HOMATHKO

Early in May, 1926, preparations for the expedition to the mysterious mountain were begun. Supplies were taken in and cached at a point eight miles up the Homathko, where we had found a trapper's cabin hidden on an island. Our party[6] was finally assembled on May 31 and in chilling rain we left McPhee's. Beyond the trapper's cabin transport became increasingly difficult with every mile. The river rarely united in a single channel or was unobstructed for any distance; jams and driftwood consisted of anything up to whole trees six feet in diameter. Frequent long portages caused serious delays and often necessitated the cutting of a trail.

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[6] Consisting of T. H. Ingram and my wife and myself, members of both the Alpine Club of Canada and the British Columbia Mountaineering Club; E. A. Agur and A. R. Munday, members of the Alpine Club; and R. C. Johnson.

We had to follow the river 25 miles measured in a straight line. In summer months the river is from 300 to 1500 feet wide and turns its flood plain into a network of channels as it sweeps back and forth against the foot of the cliffs; the valley averages about two miles in width. Bushes flourish with amazing luxuriance on the fertile flats, being further interlocked by crushing winter snows. Silt from the river invades and kills mature forest, and a mass of windfalls adds still further obstacles across the adventurer's path. Except for the absence of the sea, the mountain walls continue the fiord type of valley inland for 30 miles without any change. It is little wonder that former travelers through the valley in days when a trail existed learned nothing of what lay above and beyond the towering mountains enclosing the mighty gorge. Elevations of 7000 feet are attained in most places less than two miles from the valley floor, with higher summits in sight behind.

Heakamie Glacier came into view when we were 12 miles up the valley. From an unrevealed source it winds down a canyon five miles to an elevation of less than 600 feet in the main valley. Jewakwa Glacier, four miles to the north, issues from the same snowfield, which in all probability will be found greatly to exceed 150 square miles in extent. We saw much of it from higher elevations later; beyond this, it is entirely unexplored. It appears to average less than 8000 feet in elevation but encircles a number of prominent peaks far higher. Other glaciers issue in various directions from it.

A sudden rise of the river of 40 inches in 24 hours split our party for two days before all supplies and equipment were reassembled, and we finally decided to cache the canoe. Thereafter we back-packed everything, relaying forward about half a mile at a time, a good deal of trail cutting being needed.

Short passable sections of the old Waddington trail on the east side of the river would have helped undoubtedly; but, as it turned out, we could not have got back to the west side of the river owing to its great swiftness nearer the canyon. "Gorge" and "Scar" creeks proved formidable barriers, being too turbulent for fording and too wide for felling trees across successfully, so that we had to contrive bridges.

Animal life abounds in the valley: traces of bank beaver were numerous, wolf tracks common, deer tracks frequent, though only one doe was seen. All kinds of bears inhabit the region, but we heard them more often than we saw them. Geese with young were noted seeking shelter in brush in preference to water.

WADDINGTON GLACIER

Ten days behind schedule, we arrived at Coola Creek, supposed course of "the Bella Coola trail" according to Waddington's old map.

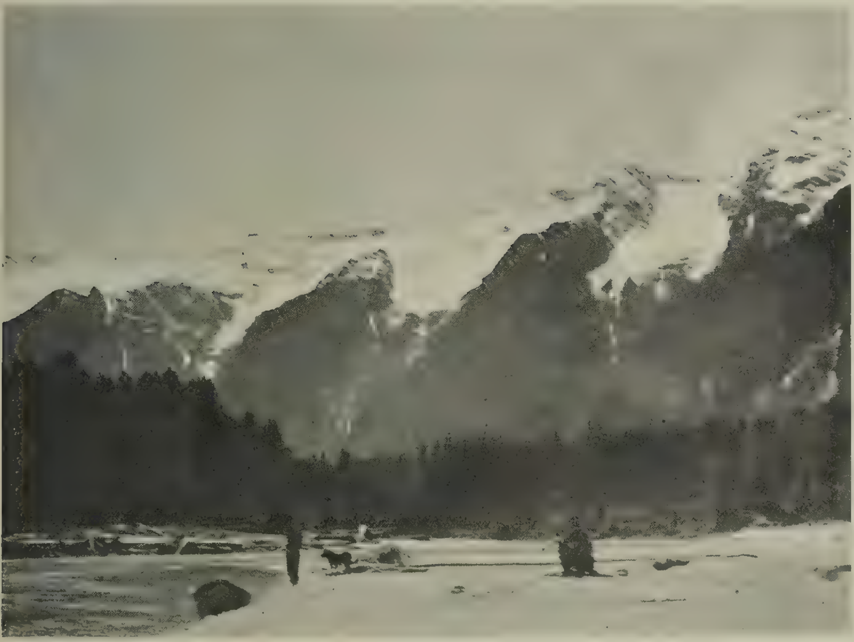

FIG. 4

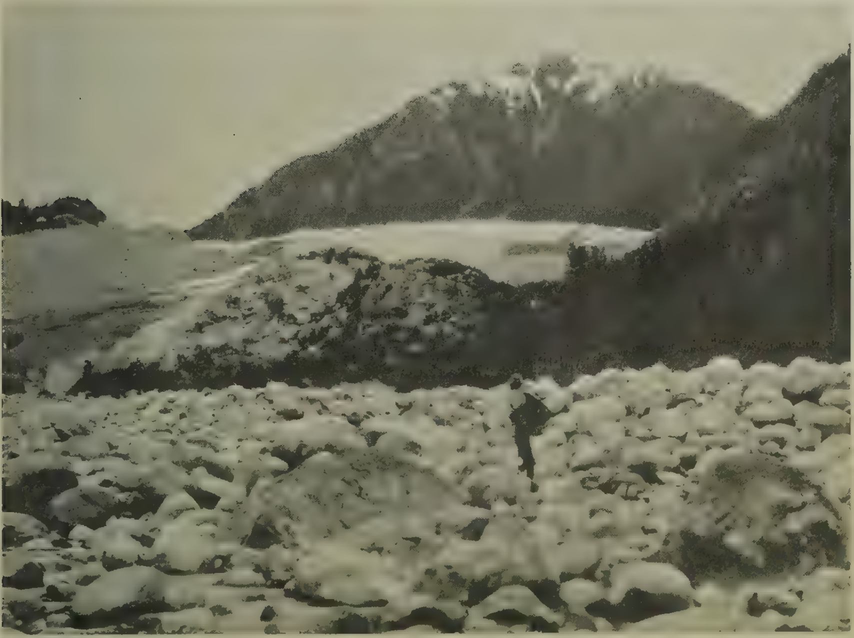

FIG. 5

FIG. 4—The 7000-foot glacier-hung wall of Homathko valley near river mouth. (Photograph by Mrs. Don Munday.)

FIG. 5—Approaching Waddington Glacier, Mt. Guardant beyond. Southern moraine, 400 feet above the ice, marks tremendous shrinkage of glacier which is going on. Elevation 1400 feet. (Photograph by Mrs. Don Munday.)

This is a mistake, as the valley offers access only to high glacial peaks and passes, the creek draining the big S-shaped glacier which we had seen from Mt. Rodney and the lower river.

Exploring this creek, Mrs. Munday and I found the tongue of Waddington Glacier two and a half miles from the river and at an elevation of only 1500 feet. The river is about 450 feet above sea level at the mouth of the creek. Four well defined moraines mark a retreat of only 400 yards from the mature forest of hemlock, fir, and cedar; on the outer moraine trees of the same species were judged to be less than 100 years of age. This retreat does not suggest the actual shrinkage of the ice, however. The glacier now occupies only one half the valley for a mile, the present south lateral moraine splitting the valley in two with its 400-foot ridge. The abandoned bed is densely grown with young conifers to the very crest of this moraine, which caps a ridge of rock in part at least. We followed the crumbling crest of the moraine a mile to a broad embayment of semi-stagnant ice at the head of the green valley and crossed the ice to the next rock promontory.

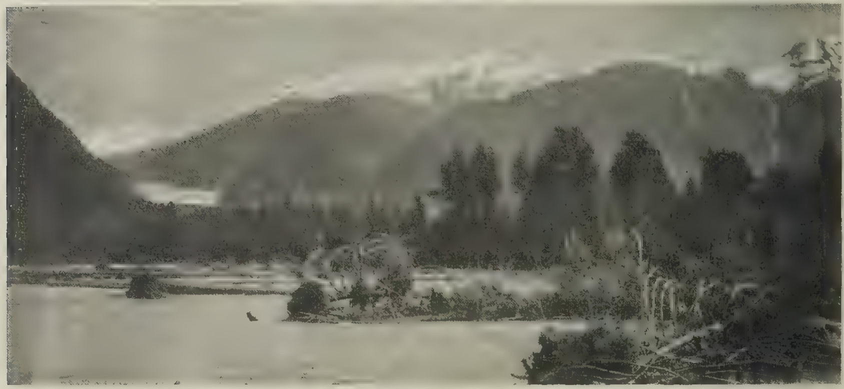

FIG. 6—Glimpse of Heakamie Glacier from Homathko River at 200 feet above sea level. (Photograph by A. R. Munday.)

The south side of the glacier is marked by three deep bays eroded in micaceous schist of unequal resistance. The rock has a more or less vertical cleavage, and rapid erosion has undoubtedly enabled the Coola valley to capture the entire flow of Waddington Glacier within comparatively recent geological times. The former course of the glacier from its snow reservoir was directly south into Scar valley, and in the broad gap west of Scar mountain the present southern moraine forms almost, or actually, the crest of the watershed between the two valleys. That this diversion of Waddington Glacier profoundly affected Scar valley, which formerly must have been dammed with this ice flood, is suggested by the presence of moraines to the westward at least 2500 feet above the floor of the valley.

Camp was shifted in two relays to Cliff Camp, at 3500 feet, beside the glacier. Rain also interfered with the next advance which was partly on the moraine, partly along cliffs, and partly along the glacier to the "Big Bend." Thence we climbed through open timber on snowy slopes on the north side of Scar Creek. For a long distance the mountainous icefall uplifts mightily above the margins of Waddington Glacier. Doubtless it pushes along a central ridge. A mile from the glacier a bit of nearly flat ground bare of snow invited pitching our three small tents at 4800 feet, practically at timber line. On the opposite side of the valley the limit was not more than 4000 feet.

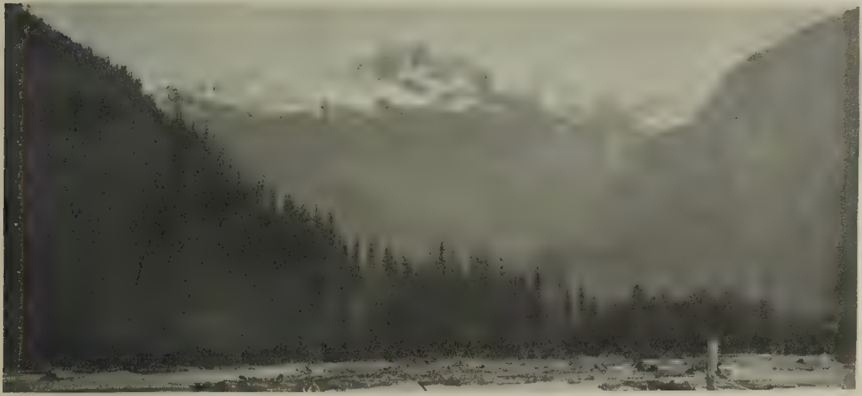

FIG. 7—The Big Bend of the Homathko River, Gorge Creek entering from right-hand valley. (Photograph by A. R. Munday.)

Clearing weather revealed Whitemantle Range on the south side of Scar Creek. Its two main glaciers thrust their snouts into the creek valley at elevations of 2000 to 2500 feet, Stocking Glacier extending eastward and filling it so that drainage from other glaciers in the upper valley passes under the ice. It was hard to realize that these ice-panoplied peaks averaged only 8500 feet instead of at least 10,000.

An easy climb to Pivot Dome, elevation 6300 feet, opened to view the upper basin of Waddington Glacier, three to four miles wide and six miles long; it was, however, too crevassed to offer a ready route toward Mystery Mountain, which presumably lay beyond a pass between handsome peaks 10,000 and 11,000 feet in height, the pass being 9000.

Thicker weather next day proved disappointing on a climb to 9000 feet along the southern rim of Waddington Glacier. Bad snow and difficulties of a mountaineering nature prevented us from reaching the summit of Mt. Agur, 10,000 feet, south of the pass.[7] Rain held us in camp on June 20, but next day we moved camp westward across

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[7] The name is suggested in honor of a member of the party who was subsequently killed in February, 1927, by being hurled over a cliff and buried by an avalanche in the mountains overlooking Vancouver, B. C.

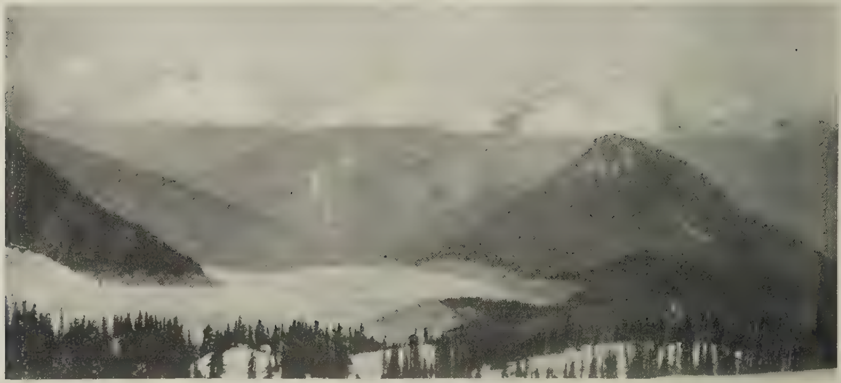

FIG. 8

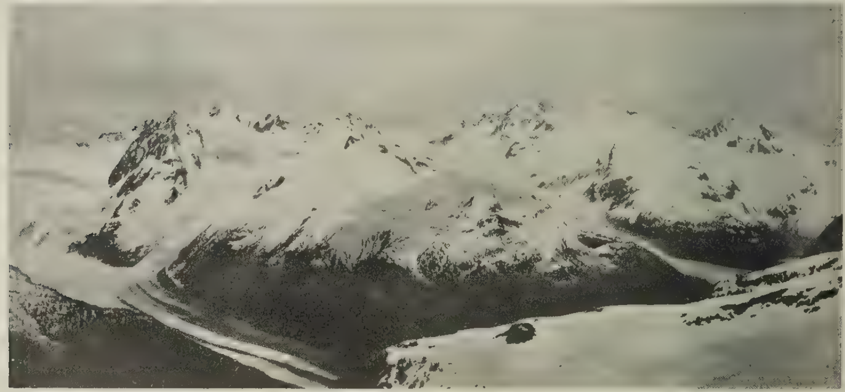

FIG. 9

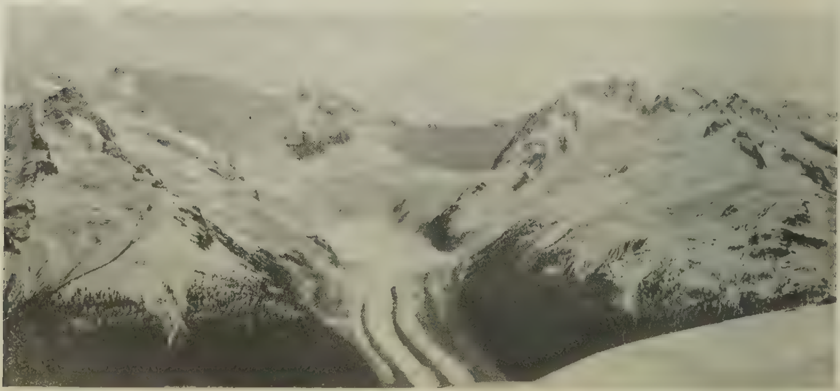

FIG. 10

FIG. 8—Part of Waddington Glacier and Scar Mountain (right), showing former course of glacier over right ridge. Homathko valley in distance. (Photograph by A. R. Munday.)

FIG. 9—Part of Scar Creek valley; Cascade Glacier at left, Stocking Glacier at right. (Photograph by A. R. Munday.)

FIG. 10—Mt. Whitemantle, Cascade Glacier, and Barb Mountain. (Photograph by A. R. Munday.)

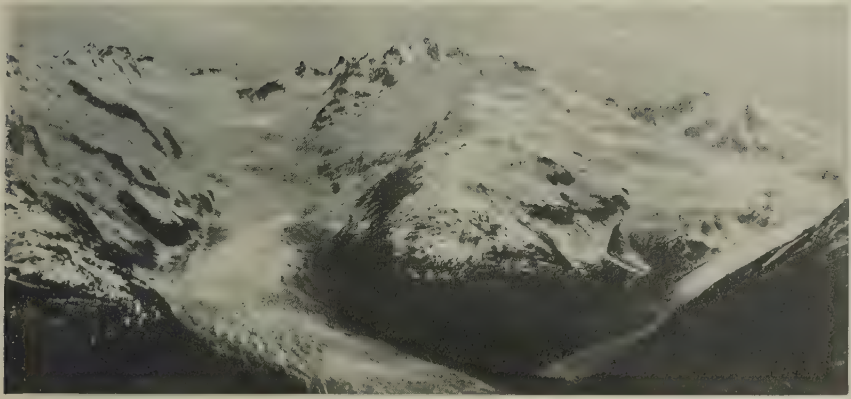

FIG. 11

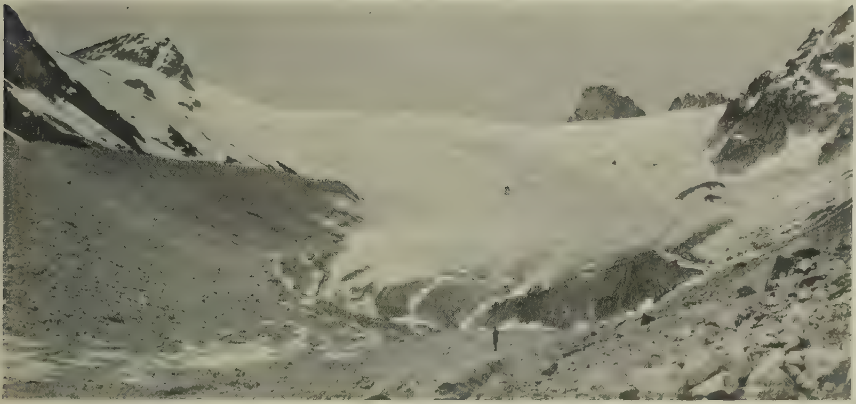

FIG. 12

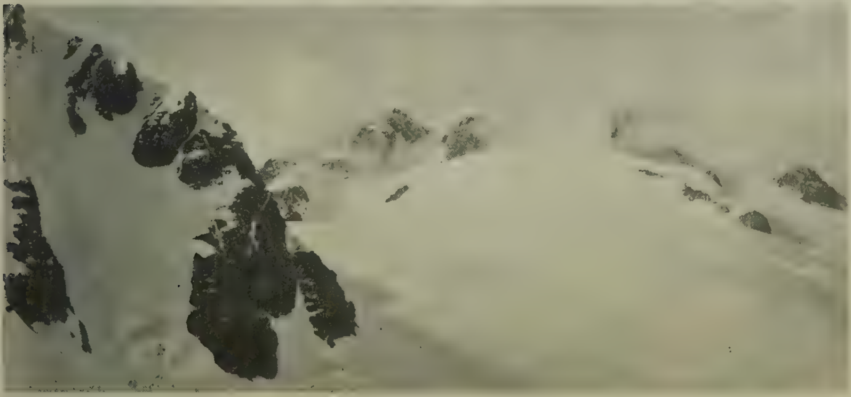

FIG. 13

FIG. 11—Stocking Glacier from near camp in Avalanche valley. (Photograph by Mrs. Don Munday.)

FIG. 12—Avalanche Glacier; crest of icefall is 3000 feet above foreground. Note absence of glacier stream from snout; it flows behind moraine on left. (Photograph by A. R. Munday.)

FIG. 13—Mystery Pass at head of Waddington Glacier. (Photograph by A. R. Munday.)

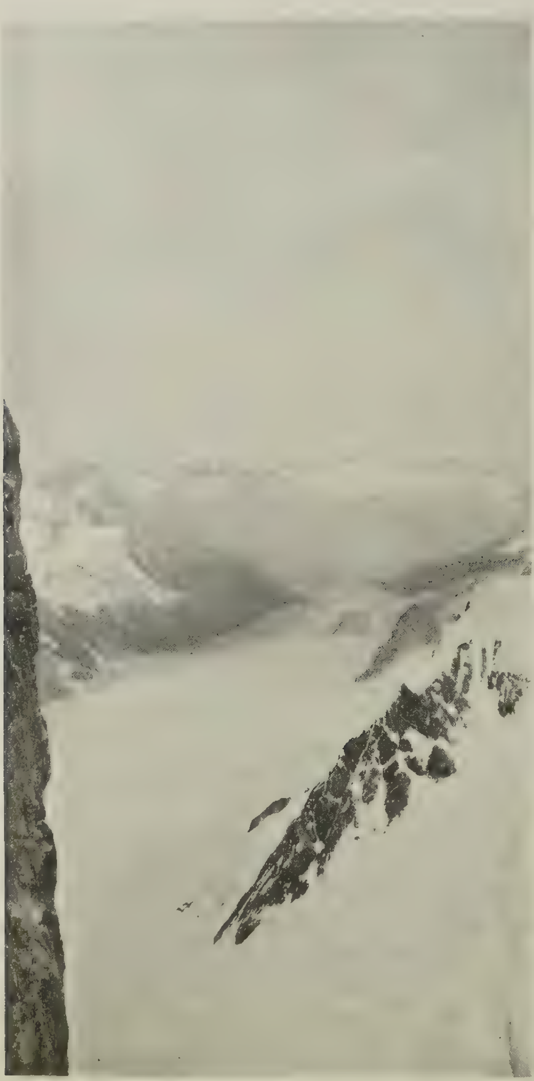

FIG. 14 -Looking down Tiedemann Glacier for 12 miles. (Photograph by A. R. Munday.)

three former glacial basins to Avalanche valley containing a glacier flowing south from the vicinity of Mt. Agur. Extensive avalanches had snapped off most trees about six feet above the ground. White avalanche lilies (*Erythronium montanum*) blossomed in profusion all around camp. Glimpses were obtained of a great glacier draining to Loughborough Inlet or Knight Inlet. The likelihood that it originated at the foot of the big mountain suggested that our goal was a considerable distance away.

MYSTERY PASS AND THE BIG MOUNTAIN

Clearing weather at last, an almost full moon, and the hope that night frost might improve snow conditions decided us to start on a final sortie—our supplies would not permit of more—on the evening of June 23. We took the pass east of Mt. Agur, whence we found a route down to a broad crevassed terrace. Dawn overtook us zigzagging tediously towards Mystery Pass. There, at 5.15 a. m., the big mountain opened to view at last. Miles of glacial valleys lay between. Its unassailable southern precipices were crowned with a still more forbidding spire tipped with a triple cornice of ice.

Descending into Ice valley we pushed on down the glacier to 7000 feet. The mountain did not improve on closer acquaintance. A hanging glacier guarded the western ridge, and the snow-crested eastern one was barred by Spearmen Peak; but a traverse of this looked possible. We turned northward up a tributary glacier, troublesomely crevassed, all the way to the 10,000-foot col where, at 2.30 p. m., the sight of a hanging glacier on the hitherto hidden summit of Spearmen Peak spelled defeat.

From our position we looked eastward down Tiedemann Glacier for 15 miles—an enormous trench evenly floored with ice. The glacier is fed mainly by avalanches discharged four or five thousand feet directly upon it. Northeastward we saw far-off brown and nearly snowless foothills bordering the interior plateau. Southward through a notch we noted Victoria Peak, 7484 feet, the highest point on Vancouver Island. To the southwest extended what will doubtless prove to be the great glacier of the region. Only in two small distant areas did any wooded slopes appear.

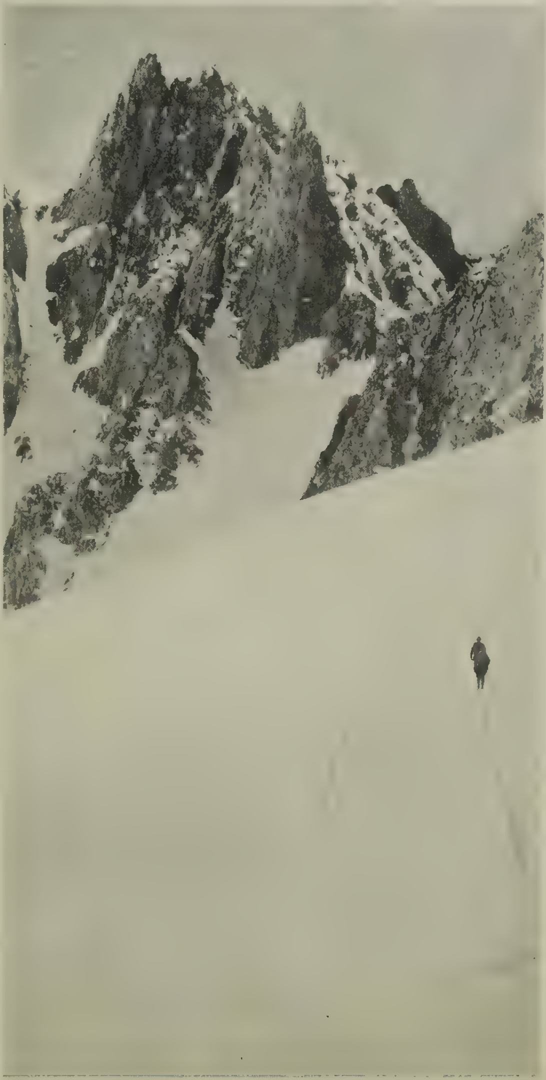

FIG. 15—Lower pinnacles of Spearmen Peak, 11,000 feet, guarding base of east ridge of Mystery Mountain. (Photograph by A. R. Munday.)

Return was made approximately by the same route. Heavy crust on the snow made travel laborious, and camp was not reached till 4 a. m. The total elevation ascended in the 31-hour trip was 10,000 feet. Aneroid readings were checked with readings recorded three times a day at Bute Inlet during our absence.

Next morning in sleet and rain we broke camp and reached Coola Creek cache the same evening. The small amount of food there allowed for no delays on the way down the river. Higher water in the valley impeded us greatly; in addition, Scar and Gorge creeks each cost us half a day. On July 1 the trapper's cabin was reached, hunger was at an end, and it was only a three hours' trip to McPhee's. From the inlet as we left we caught a brief glimpse of the great peak towering grandly over the intervening range at the head of Waddington Glacier and seeming to challenge our return.

Exploration of 1927

Exploration of the Mystery Mountain region in 1927 began with a preliminary trip by the writer and his wife to the head of Knight Inlet to investigate the source of the Franklin River. As suspected, this proved to be Mystery Glacier, seen in part the previous year. It descends to within 500 feet of sea level six miles from tidewater and is nearly half a mile wide at the snout. Ice is discharged from the snout in such quantities as to plow up the river bed and at times completely to dam the channels. The river has undermined the west margin for 400 years back from the forefoot and in July and August issued from a magnificent cave 150 feet wide. Knight Inlet has a wilder grandeur even than Bute.

Franklin valley is a glaciated gorge with walls rising from 3000 to 7000 feet. Flood channels of the river cover practically the whole valley floor. Two miles from salt water the vegetation begins to assume marked sub-alpine characteristics. Forest growth indicates that the glacier has retreated about a mile in the past 100 years, a series of short shrinkages usually intervening between long retreats. The ice has stood fully 500 feet above the present river bed.

The main trip was begun on July 18.[8] Engine trouble on Knight Inlet, high water on the Franklin, and trail-cutting delayed matters somewhat, and the combination of intense thawing at low altitudes and an intricate crevasse system on Mystery Glacier made its surface tediously rugged. Crampons proved absolutely essential on the ice.

By August 2 supplies had been relayed to a base camp at 4200 feet on the east side of the glacier and 11 miles from the mountain. A climb from here of a minor ridge 7500 feet high revealed the main features of the district and showed Mystery Glacier as probably covering fully 100 square miles, with Mystery Mountain and its intricate defending peaks clasped between the two main branches of the glacier.

The massive form of the mountain dominated the sky line, and the glacier dominated everything at lower levels. Below the forks the glacier turns an arc of 90 degrees around Icefall Point. At the same time it descends sharply for 500 feet in a magnificent and imposing

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[8] The party consisted of the writer and his wife and her sister, Mrs. E. M. McCallum.

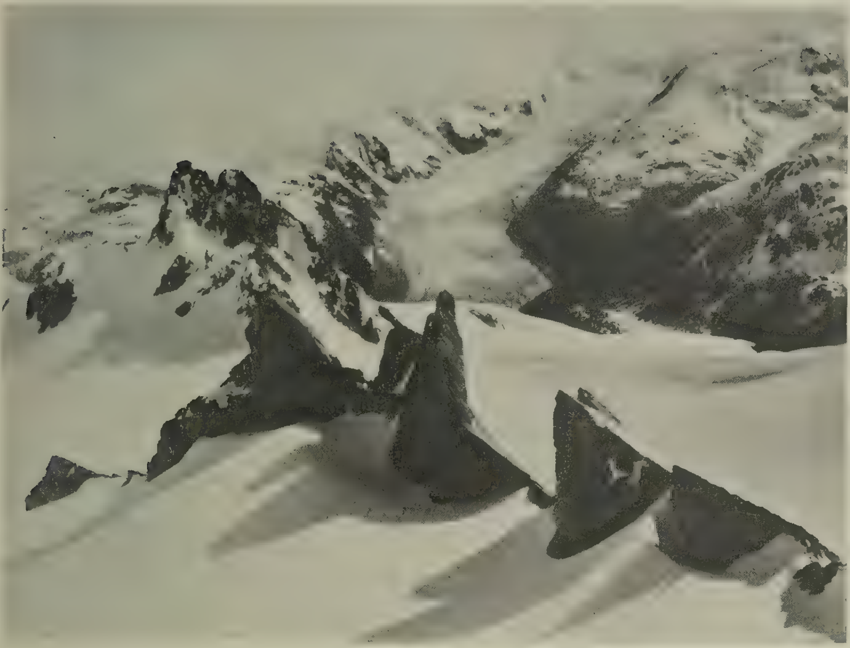

FIG. 16

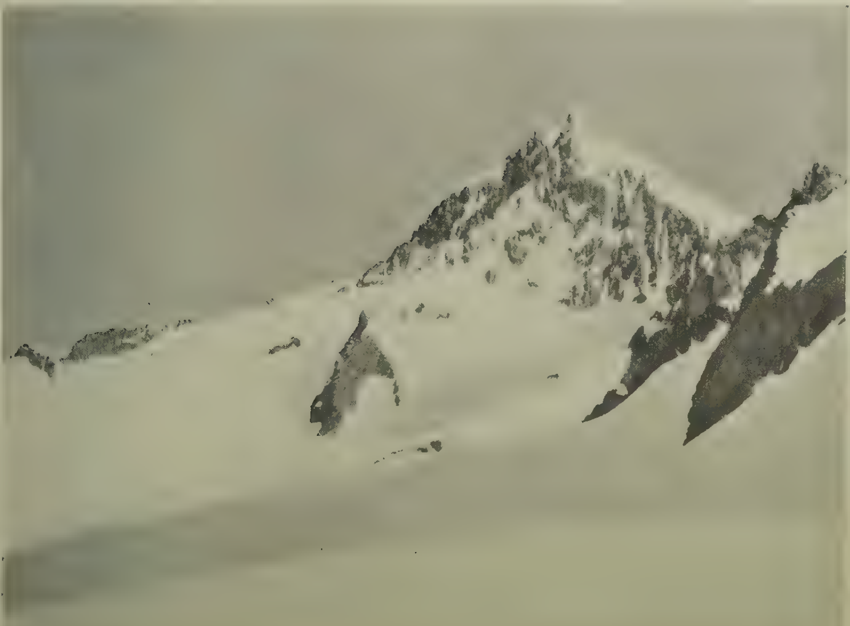

FIG. 17

FIG. 16—Advanced stage of glacial sapping between two glaciers at base of Mt. Agur. (Photograph by Mrs. Don Munday.)

FIG. 17—Mystery Mountain across nameless glacier. (Photograph by Mrs. Don Munday.)

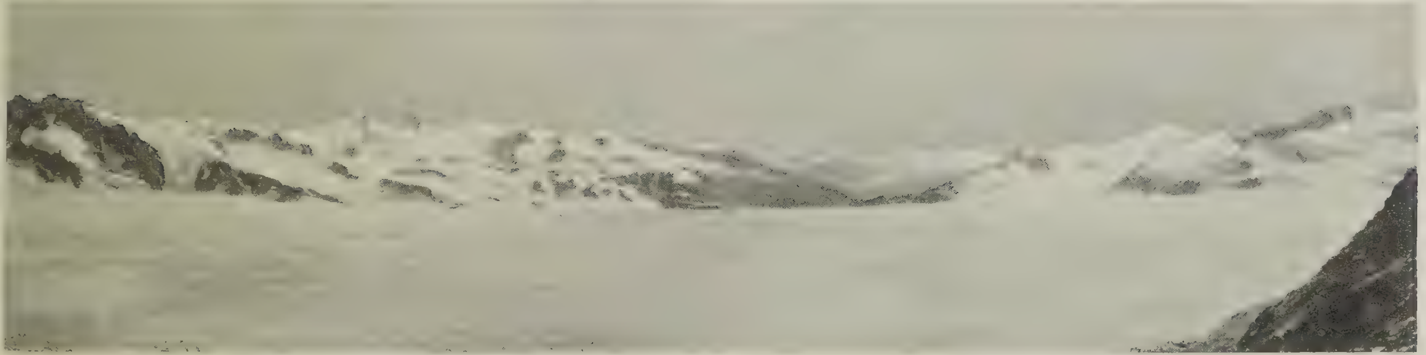

Fig. 18

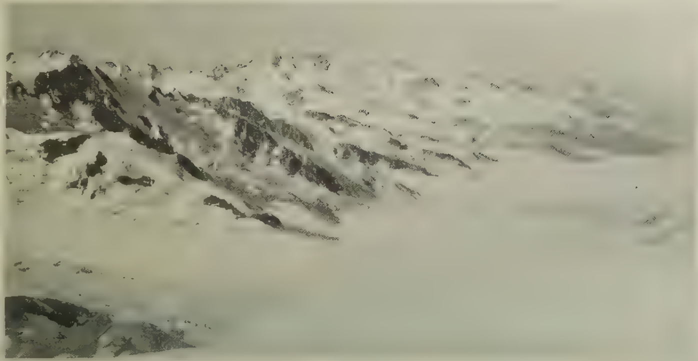

Fig. 19

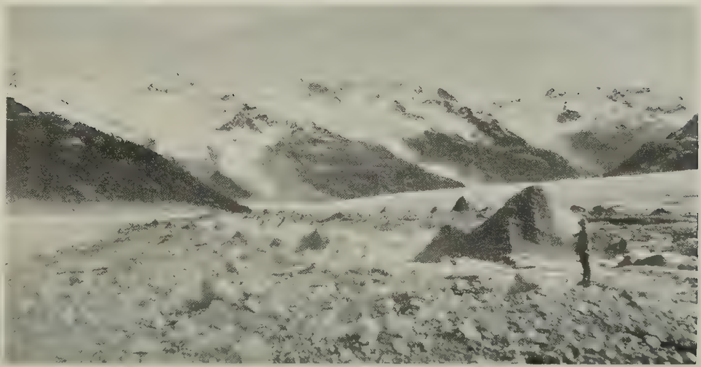

Fig. 20

Fig. 18—Looking down Mystery Glacier from fork of Mystery Glacier (southwest). Peaks in extreme distance on west side of head of Knight Inlet.
Fig. 19—Looking down east fork of Mystery Glacier from 10,000 feet on Mystery Mountain. (Photograph by Mrs. Don Munday.)
Fig. 20—8500-foot mountains along lower Mystery Glacier, from one of western tributaries, from elevation of 4500 feet.

icefall two miles in width, the splintered pinnacles maintaining orderly curving ranks which subside progressively to wavelike ridges of less and less prominence as they move down the glacier. On a lesser scale the east branch furnishes a similar spectacle where, after meeting the west branch almost end on and then being forced to describe a curve of 200 degrees, it is forced over the end of Glacier Island.

Ascent of the Mountain

This complex flow makes the glacier quite impassable for three miles; and so approach to Mystery Mountain was over Icefall Point on the west side of the glacier. The network of crevasses on the west branch was troublesome and at times not without danger. A shorter route was later discovered by traversing the icefall of a tributary glacier at risk of fusillades of ice from the impending masses above. From a bivouac at 7000 feet on a cliff edge, an elevation of 11,000 feet on a spur of the great west ridge was reached by noon. This climb was wisely abandoned—a rock fall of landslide proportions was witnessed across the only route of advance.

After a return to base camp the attack was transferred to the east ridge of the mountain from a bivouac at 7200 feet on cliffs on the west side of the east branch of the glacier. Masked, thinly-roofed longitudinal crevasses on the trunk glacier were negotiated in moonlight. An icefall of 2000 feet under the southeastern cliffs proved almost insurmountable. A rock wall of 10,500 feet could not be mastered, and the glacier was regained only at dusk.

The forbidding west ridge was then tried directly from its west base. It comprises 10 peaks from 10,000 to 11,500 feet high; and three of the highest were crossed in a climb to a height estimated at 13,000 feet, only 200 feet below the north summit. At 6.40 p. m., after 14 hours of climbing, an exceptionally violent electrical storm forced retreat over a route that had been difficult enough in the daylight.

Until August 29 the weather remained consistently poor, finally settling down to seven nights and six days of continuous rain, in the middle of which a creek three feet wide swelled in ten minutes at night to 100 feet and inundated camp. A few fine days followed, but the new snow made even the minor peaks unapproachable; and so further attempt on Mystery Mountain had to be abandoned until 1928.

Conclusion

The Coast Range has a general north-northwesterly trend from the Fraser River, but in the vicinity of latitude 51° for upwards of 100 miles it assumes a more westerly direction, and here are concentrated the maximum elevations of the range, carved into sharp jagged peaks out of the granitic rocks of the Coast Range batholith. Mystery Mountain is composed of schistose diorites, tilted to a nearly vertical position by a massive formation of lighter-colored granodiorite to the north; the Teidemann group is composed of this, the Teidemann Glacier following the contact in part. Part of this contact, however, is embodied in Mystery Mountain parallel to the summit ridge and close under the summit, the aplite-streaked schists everywhere attaining the highest elevation. They continue westward for at least 12 miles in formidable peaks ranging from 10,000 to 12,000 feet.

Glaciation, past and present, is notable for the vastness of its scale. The Homathko tongue of the Pleistocene ice sheet filled the valley to at least 5000 feet, imparting to the landscape all the typical features of intense glaciation; grooved and polished cliffs are still to be seen almost destitute of vegetation. A more recent stage of glaciation is recorded by huge ice-borne rocks in the river flats at Beaver and Gorge creeks. Between Scar and Coola creeks the river is deepening its channel through what has all the appearance of a morainal deposit across the valley.

Absence of surface moraines is most striking on Waddington Glacier, even the margin of the ice being clearly exposed down to within half a mile of the snout, and from thereon the covering is never thick. Absence of extensive areas of exposed rock around the snowfield account for the insignificant quantity of débris contained in the ice. Unfortunately time did not permit study of a series of ancient moraines on truncated spurs of Scar valley at 4500 feet and over.

As to the rate of recession of glaciers in the southern half of the Coast Range practically no information exists.[9] In estimating the age of recent moraines allowance ought to be made for the short period required for vegetation to gain a foothold owing to the moist climate of the Pacific slope. The average precipitation is 58.76 inches a year for Vancouver and 68.90 for Bute Inlet; but these figures probably have little bearing on the precipitation at higher levels of the range as a whole. In mountain valleys within 10 to 30 miles of Vancouver, and only a few hundred feet higher, the precipitation ranges from 80 to 138 inches a year. On the rainy west coast of northern Vancouver Island five stations give an average of 112.88 inches, and the lower elevation of the island mountains offers a lessened barrier to the sweep of the moisture-laden winds from the Pacific into the icy heart of the highest part of the Coast Range.

The valley of the Klinakline River, west of the Franklin, contains a partly explored glacier of vast size, descending to the same elevation as Mystery Glacier and probably covering an even greater area. West of the Klinakline River a peak has been triangulated as 11,714 feet, but its glacial surroundings are entirely unexplored.

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[9] On the retreat of glaciers in similar latitudes of the Rockies see Howard Palmer: The Freshfield Glacier, Canadian Rockies, *Smithsonian Misc. Colls.*, Vol. 76, 1924, No. 11. Noted in *Geogr. Rev.*, Vol. 15, 1925, p. 302.

ASTRONOMICAL OBSERVATORIES IN THE MAYA AREA

Oliver Ricketson, Jr.
Carnegie Institution of Washington

THE oldest dated ruins so far discovered in the Maya area lie in the center of the northern portion of the Department of Petén, Guatemala. They were first reported by Dr. Sylvanus G. Morley in 1916 who named the site Uaxactun, a combination of two Maya words, *uaxac*, meaning eight, and *tun*, meaning stone. This name suggested itself, as Stela 9 in this city is inscribed with a date in the Maya calendric system equivalent to June 10, 68 A. D., the earliest date recorded on a monument contemporaneous with the occupation of the city that has yet been found in the New World.[1] The original Maya name of the city may never be known, so completely has the combination of time, a humid climate, and the ruthlessness of the Spanish *conquistadores* obliterated evidence pertaining to the once wide-spread Maya civilization. In 1925 the Government of Guatemala granted permission to the Carnegie Institution of Washington to carry out archeological investigations at this site.

NORTHERN PETÉN AND ROUTES THITHER

Although we have every indication that the low-lying lands in the Petén District were once the seat of a dense and highly developed native population, today they constitute an almost inaccessible area, marked "Despoblado" on the maps. Except for a sparse population around the shores of the beautiful lake, Petén Itza, and on the picturesque island where Flores, the modern capital of the district, is situated, the northern part of the Petén is entirely destitute of inhabitants. North of Uaxactun stretches an unbroken wilderness, unexplored and unmapped, extending without interruption to the southernmost settlements in the states of Campeche and Quintana Roo, Mexico. A torrential tropical rainfall during eight or nine months of the year, which makes the ground beneath the dense jungle almost impassable, is followed by a three to four months season of great

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[1] In the modern method of writing a Maya date it is 8.14.10.13.15 8 Men 8 Kayab, which means: 8 baktuns of 144,000 days each, 14 katuns of 7200 days each, 10 tuns of 360 days each, 13 uinals of 20 days each, 15 kins of 1 day each; bringing the count to the day 8 Men falling in the month Kayab on the eighth completed day. The correlation used is that of Herbert J. Spinden. The only two earlier dates are those of the Tuxtla Statuette, 8.6.2.4.17 8 Caban 0 Kankin, and the Leyden Plate, 8.14.3.1.12 1 Eb 0 Yaxkin, the former being, roughly, 168 years earlier, and the latter about 7 years earlier, than the Uaxactun date. Both of these earlier dates are carved on small, portable jadeite objects.

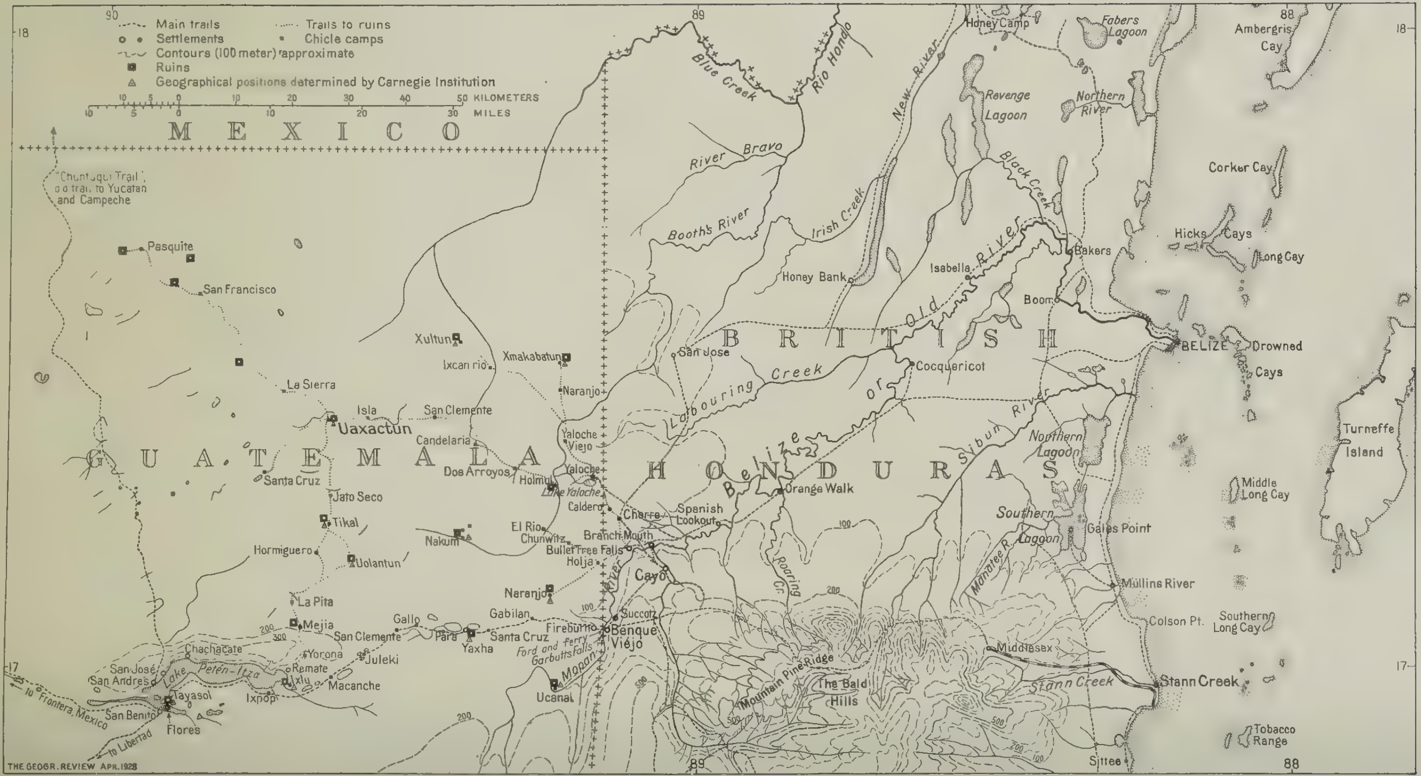

Fig. 1—Map showing the distribution of known Maya ruins in the Petén region of northeastern Guatemala and the chief approaches thereto. The Guatemalan section is based on a map of the chicle camps and trails of the P. W. Shufeldt Company (work of Captain Frank Vans Agnew and Didier Masson) with latitude and longitude of the ruins by the Carnegie Institution. All permanent sites in the Petén region as well as some temporary sites are included. Parallel rows of low hills run northeast and southwest with swamps (*bajos*) from one to five miles at the foot of the steep southerly slopes. There is no open country north and east of Petén: visibility in the jungle is well under 75 feet in any direction. Scale of the map approximately 1: 1,300,000.

drought, when the traveler suffers from lack of water as much as he before suffered from a surplus. The rock is limestone, the drainage of the region subterranean; no springs and practically no streams or rivers are to be found. The remoteness of the gateways themselves from regular routes of travel, together with a relatively undeserved reputation for insalubrity and danger, is also a deterrent factor.

It is possible to reach northern Petén from four points: from Guatemala City overland by mule, ten to twenty days; from Frontera, Mexico, up the Usumacintla River to Paso Caballo on the Rio San Pedro Martyr; from Valladolid or Peto, Yucatan, overland by mule, a journey which few have ever attempted; and, lastly, from Belize, the capital of British Honduras. This last is the preferable route and is the one followed by the expeditions sent out by the Carnegie Institution of Washington.

Belize, the name of which is supposed to be an Hispanicized corruption of "Wallace," a seventeenth-century freebooter who there found fresh water and shelter between sorties against the treasure-laden galleons of Spain, is an hospitable town basking on the shores of the Caribbean. Here supplies and provisions of all sorts can be had, and a launch can be chartered for the ascent of the Belize River to El Cayo, the head of navigation, where mule trains are secured for the trip to the interior.

These river boats, drawing eighteen inches, are effective and unique. They are a local adaptation and are called "tunnel boats" because the propellor is countersunk in a well at the stern to prevent injury from rocks when the river is very low or the boat is passing through rapids. The tunnel boat usually carries a crew of eight or ten negroes and tows two "pitpans." These last are graceful barges of hand-hewn mahogany, about sixty feet long and wide enough to take a gasoline drum lengthwise. Each pitpan requires a steersman and two bow-boys with poles which are picturesquely called "milady sticks." These large crews are needed for navigation of the rapids encountered in the last two thirds of the trip, where frequently each unit of the "tow" has to be warped up separately. The ascent of the river takes from three to five days, sometimes longer if the water is low.

From El Cayo to Uaxactun is a three or four days' journey by mule. On an undersized beast, struggling through the gummy mud of logwood swamps and thorned vegetation, it is extremely trying. One never gets a view of open country, and both beast and rider are constantly attacked by an endless variety of insects. Seldom is it possible to cover more than twelve miles a day, and halts must be made where water holes are available, whether they lie three or six hours' distance apart.

But if the going is hard the ruins themselves are inspiring. Uaxactun, though by no means one of the greatest centers, completely covers the artificially leveled top of a hill with a mass of temples and buildings and extends for several miles in each direction with two outlying groups reached by artificial causeways. In its well-paved plazas stand stone monuments bearing dates beginning with 68 A. D. and extending to 639 A. D.—five hundred and seventy-one years of continuous occupancy at the very least. How long the city was settled before the Maya carved their dates on stone no one has ventured to guess, much less how long a period must have elapsed before their extraordinary calendric system was finally developed. This system breaks upon our view in full flower, the characters already conventionalized and carved upon stone.

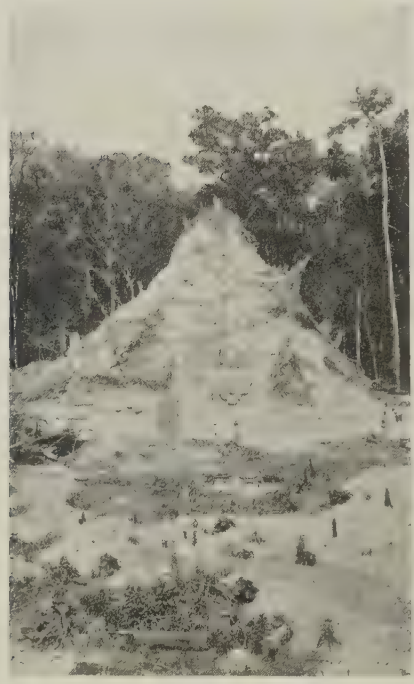

FIG. 2

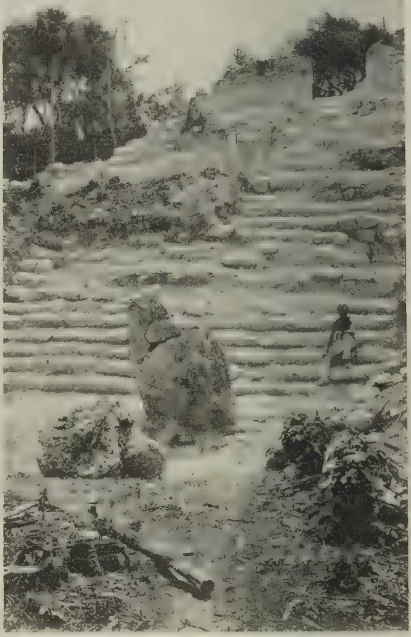

FIG. 3

FIG. 2—Looking west across the Plaza of Group E, Uaxactun, Guatemala. Temple VII is shown with location of stairway and masks. Stela No. 20 can be seen directly in front. (Courtesy of the Carnegie Institution.)

FIG. 3—The Plaza, Group E. Looking east at Stela No. 19 and main stairway in front of Temple E II. (Courtesy of the Carnegie Institution.)

ASTRONOMICAL OBSERVATORIES: THE CARACOL

We now have at least two bits of evidence as to how the Maya went about making their astronomic observations. The first of these occurs in the building called the "Caracol," at Chichen Itza, Yucatan; the second is the so-called "Solar Observatory" at Uaxactun.

The Caracol is a circular tower with four outer doors facing the cardinal points of the compass.[2] Within is a circular corridor from which four more doors, facing midway between the cardinal points, lead into another circular corridor. This inner circular corridor surrounds a masonry core, inside which a small, spiral staircase leads to the upper part of the building. Unfortunately, the upper terminus of the stairway cannot be ascertained, for, a little more than halfway to the top, the whole northern section of the building has completely fallen. Near the top of the structure is a flat area from which open three rectangular, horizontal shafts known as *ventanas*, or windows. The largest of these, Window 1, faces west and was until recently the only one known. Windows 2 and 3, uncovered during the repair of the building in 1925 by the Chichen Itza Project of the Carnegie Institution, face southwest and south, respectively. Figure 6 (not drawn to scale) shows their relative position and directions.

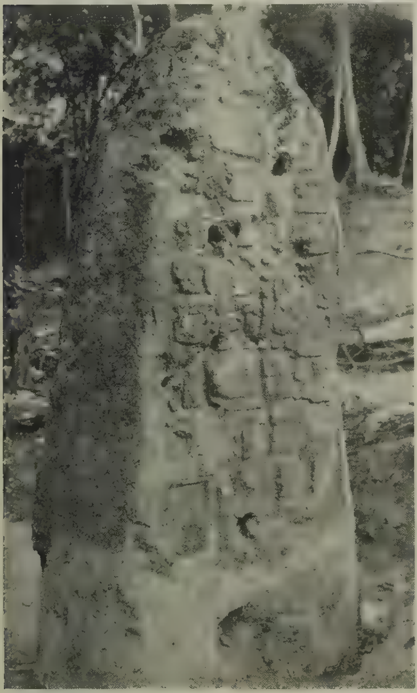

FIG. 4

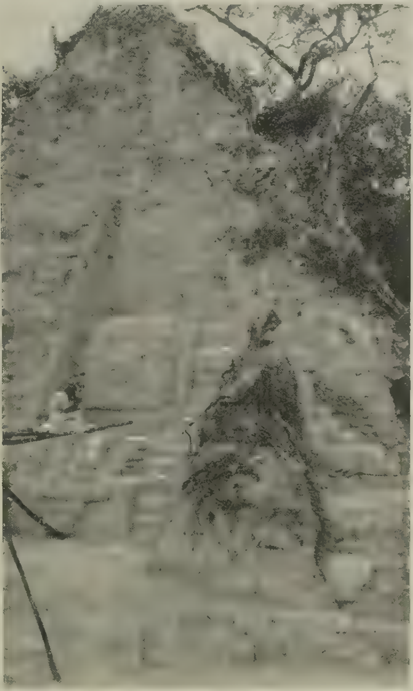

FIG. 5

FIG. 4—Glyph blocks on Stela No. 18, Group E, Uaxactun, Guatemala. This monument bears the date 8.16.0.0.0 3 Ahau 8 Kankin, or April 5, 97 A. D. in our chronology. (Courtesy of the Carnegie Institution.)

FIG. 5—Uaxactun, Guatemala. Group E. Closer view of primary temple, with masks, found on Mound E VII. Looking west. (Courtesy of the Carnegie Institution.)

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[2] W. H. Holmes, "Archeological Studies among the Ancient Cities of Mexico," *Field Museum of Nat. Hist. Publ. 8* (*Anthropol. Ser., Vol. 1, No. 1*), 1895, illustrates the structure very completely: see pp. 115–120.

It is the writer's belief that these three windows opened from a rectangular room to which the hidden spiral stairway gave access. There may have been other windows, but in this regard nothing can be stated with certainty, as the northern and eastern sections have completely fallen. In regard to the results obtained from careful measurements of the three windows still *in situ*, however, there can be no doubt. The directions of these windows and of their diagonals were taken with a Brunton compass, and the data were submitted to the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, with a mere suggestion that the important lines of sight were not the actual directions of the windows themselves but of their diagonals. Their findings are best described in a letter from Dr. Louis A. Bauer, Director of the Department of Terrestrial Magnetism, from which I will quote:

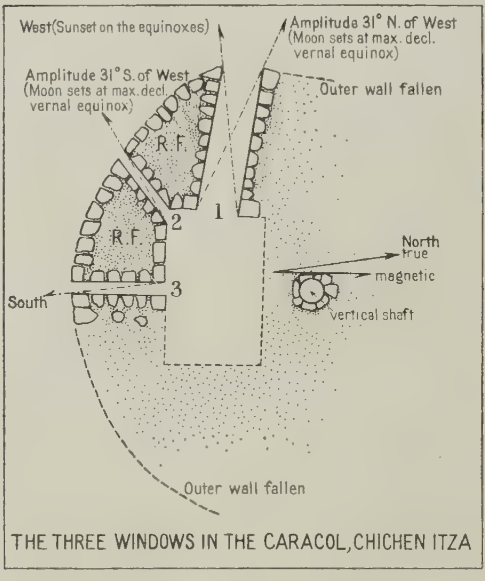
West (Sunset on the equinoxes)
Amplitude 31° N. of West (Moon sets at max. decl. vernal equinox)
Amplitude 31° S. of West (Moon sets at max. decl. vernal equinox)
Outer wall fallen
R.F.
R.F.
1
2
3
North true
magnetic
South
vertical shaft
Outer wall fallen
THE THREE WINDOWS IN THE CARACOL, CHICHEN ITZA

FIG. 6—Diagram of the three windows in the Caracol, Chichen Itza. The location of probable observer's room is indicated by a dashed line. The windows or shafts are numbered 1, 2, and 3. R. F. is the rubble fill of stone faced walls. (Courtesy of the Carnegie Institution.)

> . . . I inclose a diagram of directions or azimuths of the sun and moon at the time of their setting at Chichen Itza when their declinations for the year are greatest; also a tracing to fit over the diagram, showing the azimuths of the windows and their respective jambs.
>
> In the following notes the jambs are designated *right* and *left* as when *looking out*, and azimuths or directions are astronomical:
>
> *a*. Window 1. The direction, *right inner* jamb to *left outer* jamb, is *due west*.
> *b*. Window 3. The direction, *right inner* jamb to *left outer* jamb, is *due south*.
> *c*. Window 2. The direction, *left inner* jamb to *right outer* jamb, is in azimuth 59 reckoned westward from south, or in *amplitude 31*.
> *d*. Window 1. The direction, *left inner* jamb to *right outer* jamb, has the same amplitude north of west (31) as *c* is south of west.
>
> The amplitude of the sun at setting on March 21 was 0°, or due west, which accords with the direction under *a*.
>
> The directions *c* and *d* are the directions of the moon at setting when its ascending node is in the vernal equinox; that is when its declination is a maximum, about 28° 36′. Nothing apparently marks the direction of its setting nine and a half years later, when its maximum declination for the year is reduced to about 18° 25′ and its amplitudes become 20° north or south.

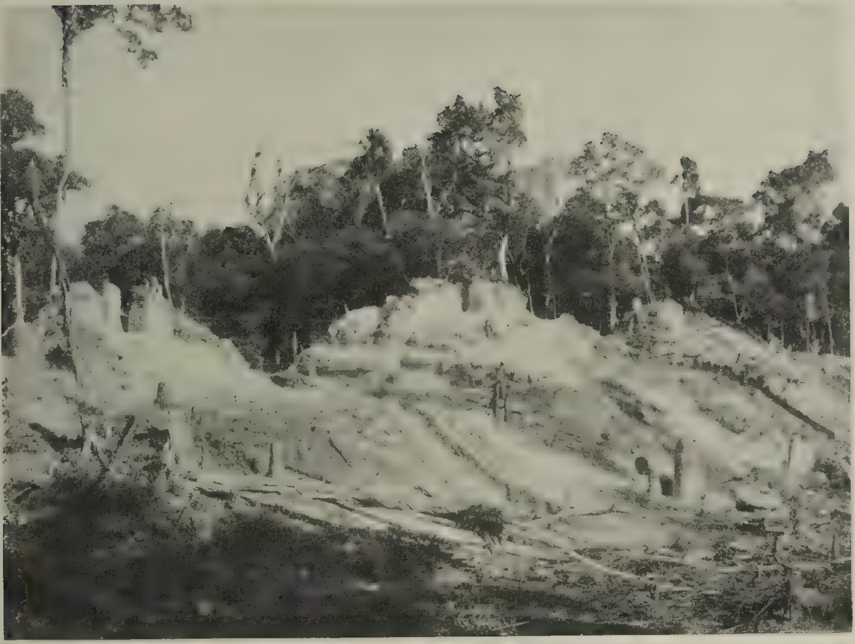

FIG. 7

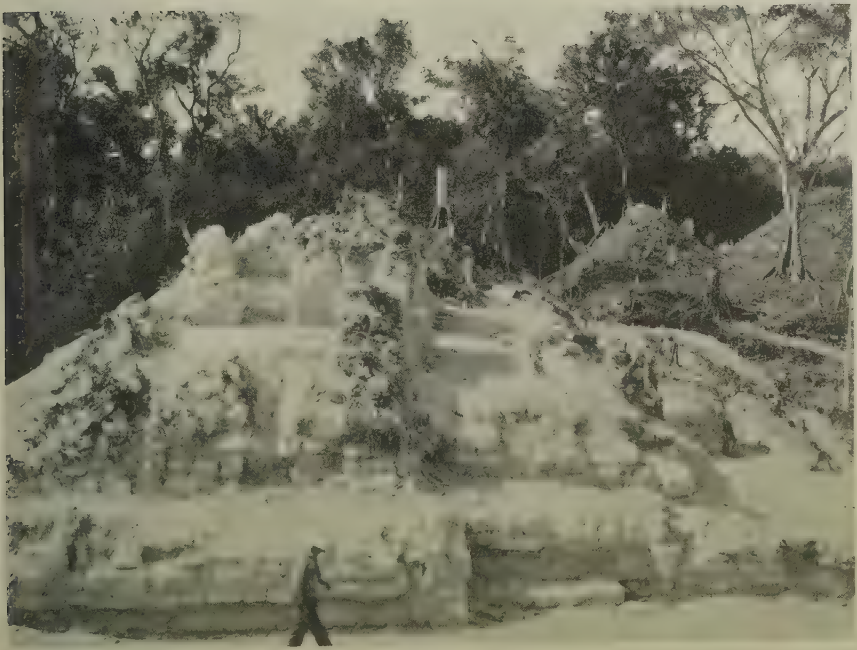

FIG. 8

FIG. 7—Temples E I, E II, and E III as seen from the northwest. Stelae Nos. 18 and 19 are just at the base of the substructure platform, to the right. (Courtesy of the Carnegie Institution.)

FIG. 8—A view of Temple E II looking south from Temple E I after excavation. The damaged condition of the masonry is evident. (Courtesy of the Carnegie Institution.)

Window 3 is not high enough for direct observations of the sun at noon or the moon at meridian passages; hence, if it was constructed for such observations, it must have been the shadows of the jambs cast by the sun or moon that were noted.

Directions *a*, *b*, *c*, and *d* mark astronomical directions of local importance, whether intentionally or unwittingly; but two directions remain for which I can assign no reason at the present time.

The Uaxactun Observatory

These truly remarkable results seem the more significant when considered in connection with work done along the same lines at Uaxactun. Since the discovery of Uaxactun in 1916 it has been visited by several expeditions sent out by the Carnegie Institution of Washington. In 1923 the seventh Central American expedition, under the direction of the writer and Mr. Witherow Love of the Department of Terrestrial Magnetism, spent several months in the Petén District locating the exact geographic positions by latitude and longitude of twelve important ruins, of which Uaxactun was one. In 1924 the eighth expedition, directed by Mr. Frans Blom, made an accurate plane-table survey of the city. Although no excavation was possible at that time, Mr. Blom drew attention to the fact that the arrangement of buildings, mounds, and stelae in the easternmost plaza, called Group E on his map, suggested its probable function as a solar observatory

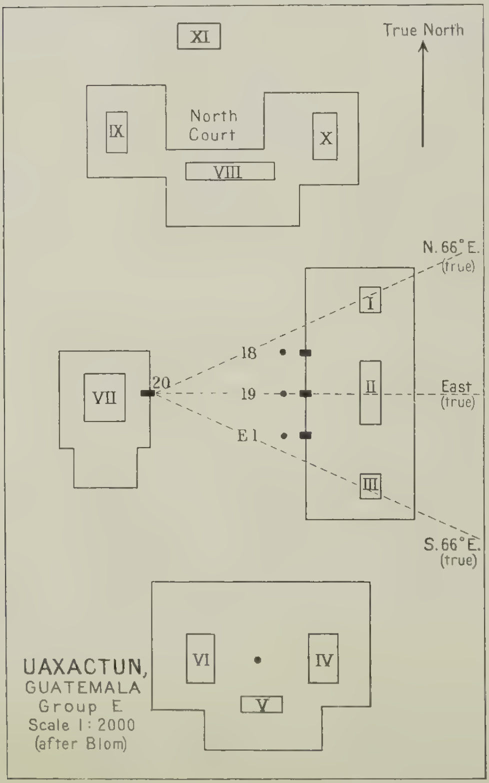

Fig. 9—Ground plan of Group E, Uaxactun, before excavation. After Blom. (Courtesy of the Carnegie Institution.)

The ground plan of this group, as it appeared before excavation, is shown in Figure 9. Making his observations from Stela 20 as he faced the east, Mr. Blom noted that the true east-west line passed through the estimated center of Mound E II, and that lines drawn to the apparent centers of Mounds E I and E III were 24° north and south of the true east-west line. The geographic position of Uaxactun having been determined the year before, it was possible to determine both the magnetic declination of the compass and the amplitudes of the sunrise points for that location. The latter were found to be 24.4°

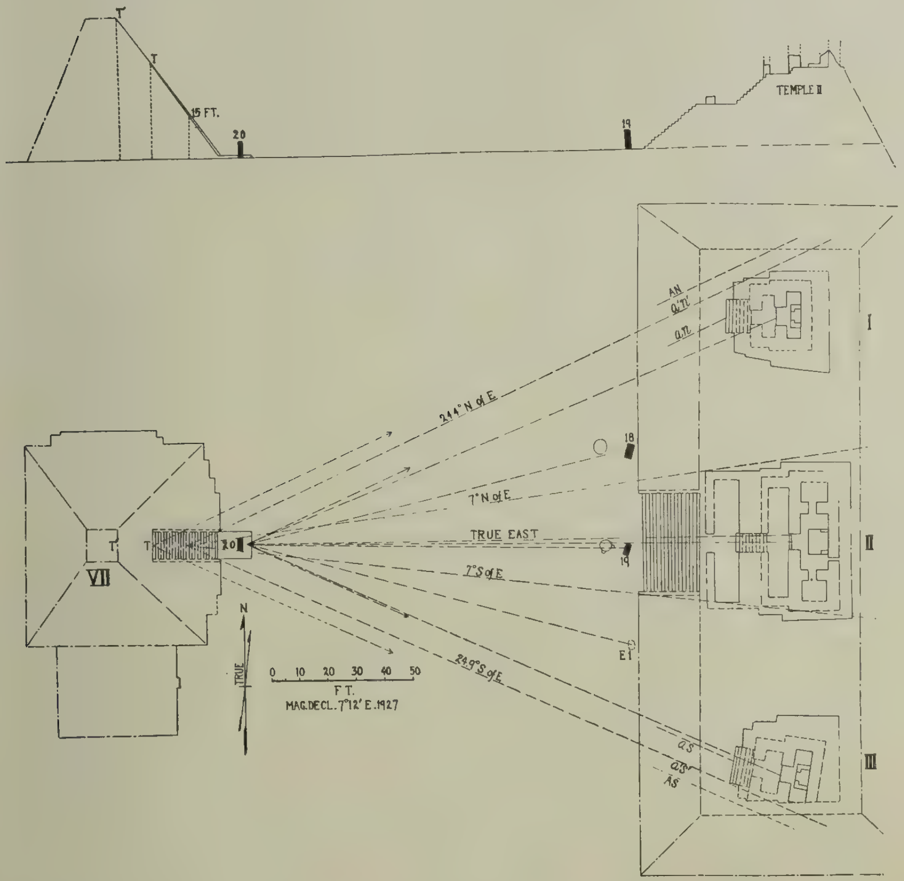

FIG. 10—Ground plan of Temples E I, E II, and E VII, at Uaxactun, as excavated in 1927. Above the plan is a cross section along an east-west line. (Courtesy of the Carnegie Institution.)

north of east and 24.9° south of east (visible horizon) on June 22 and December 22 respectively—i. e. the summer and the winter solstices. The true east-west line gave, of course, the position of sunrise on both the vernal and autumnal equinoxes.

When excavation was begun in 1926, under the direction of the writer, this group was selected for investigation. The results of two seasons' work are summarized in Figure 10. Mounds E I, E II, and E III were found to be temples, the floor levels of which lay ten feet above the substructure platform which underlies all three of them. This substructure platform is fifteen feet above the plaza level. The true east-west line passes just within the north jamb of the doorway of Temple E II and up the mid-line of the stone stairway which was found on the east slope of Mound E VII. The directions for the amplitudes of the sun on June 22 and December 22 were found to strike the front steps of Temples E I and E respectively if taken from Stela 20. These directions are shown on Figure 10 as the lines *a n* and *a s*. But, because of the fifteen-foot substructure platform beneath Temples E I, E II, and E III, no observations of sunrise points on the horizon could possibly be made from the plaza level, and as a point of observation Stela 20 has to be abandoned. The directions taken from the top of the stairway on Mound E VII pass too far outside the limits of Temples E I and E III. They are shown in Figure 10 as lines *A N* and *A S*. But from a point fifteen feet vertically above plaza level on the mid-line of the stairway on Mound E VII the same directions give the lines *a′ n′* and *a′ s′*, which just touch the corners of Temples E I and E III respectively. This point was arbitrarily chosen because it is the lowest possible point from which a view could be had of the horizon over the fifteen-foot substructure mound.

Significant Dates in the Maya Calendar

The angles subtended by Temple E II from this point were then examined. Because of the dilapidated condition of this temple one wall alone could be located with sufficient precision for the necessary measurements. This was on the northwest corner of the temple platform and fortunately proved quite enough for the purpose, since the temple walls proper must have stood inside the point thus indicated. The bearing of this corner was found to be 7° north of east, and this direction was submitted to the Department of Terrestrial Magnetism for analysis. The Department replied that the directions 7° north and south of the true east-west line were apparently of no astronomic significance for Uaxactun; they merely marked the points of sunrise on March 3 and April 6 to the north and September 6 and October 10 to the south. These dates, however, have considerable significance in the Maya calendric system. They occur repeatedly on monuments throughout the entire area, especially the April 6 and September 6 dates; and, if we examine the three stelae standing in the plaza of Group E in Uaxactun, we find the following interesting approximations:

Stela 18	8.16.0.0.0	3 Ahau	8 Kankin	April 5, 97 A.D.
Stela 19	8.16.0.0.0	3 Ahau	8 Kankin	April 5, 97 A.D.
Stela 20	9. 3.0.0.0	2 Ahau	18 Muan	April 3, 235 A.D.

As the point on Temple E II used in this calculation is the most northerly point possible, being a well-defined corner of the platform beneath the temple, the temple walls must lie to the south of it, or towards April 5 and April 3, the dates on the stelae in this group.

It is interesting to note in this connection that Dr. Spinden in his book "The Reduction of Mayan Dates" reaches a conclusion not too dissimilar regarding the two famous "Piedras Pintadas" at Copan, Honduras.[3] These two stelae, four and a half miles apart across a valley, Stela 12 located on the east and Stela 10 on the crest of a hill to the west, have long been considered as a possible astronomical base line. Stela 12 bears two dates:

9.10.15.0.0	6 Ahau	13 Mac	January	11, 388 A.D.
9.11. 0.0.0	12 Ahau	8 Ceh	December	15, 392 A.D.

and Stela 10 bears the date:

9.10.19.13.0	3 Ahau	8 Yaxkin	September	6, 392 A.D.

Dr. Spinden supposes that the line of sunset originally established between these two monuments occurred on September 6 and its reciprocal April 5 and that later this line was shifted, presumably by moving Stela 10 to the north, so that it marked the line of sunset on April 9 and September 2. On Altar U at Copan the following dates probably record this change:

9.15. 8.10.12	2 Eb	0 Pop	April	9, 480 A.D.
9.15. 9. 0. 2	9 Ik	10 Mol	September	6, 480 A.D.
9.15. 9.10.17	3 Caban	0 Pop	April	9, 481 A.D.
9.16.12. 5.17	6 Caban	10 Mol	September	2, 503 A.D.

Dr. Spinden also cites many other inscriptions in support of this argument.

Dr. Morley is of the opinion, though he advances it necessarily without proof, that the April dates marked religious festivals connected with the beginning of the agricultural year. This theory presupposes that the ancient Maya practiced the "milpa" system of agriculture which is in use throughout the region today. This system consists in felling the jungle at the beginning of the dry season, burning it during April, and planting shortly thereafter at the beginning of the rains. Whether "milpa" agriculture, with its attendant waste of land, could have supported a dense population is debatable.

More work of this sort in the field and in the study will undoubtedly prove of value as a means toward the complete decipherment of the Maya hieroglyphs and a better understanding of their relationship to Maya civilization in general. It is sincerely to be hoped that all investigators in this field, whether visiting old sites or exploring new ones, will take accurate and copious bearings whenever the opportunity offers or the faintest suspicion arises that the arrangement of buildings or structural features may have been designed in accordance with astronomical directions.

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[3] H. J. Spinden: The Reduction of Mayan Dates, *Papers Peabody Museum of Amer. Archaeology and Ethnology*, Vol. 6, No. 4, Cambridge, Mass., 1924.

124577

AN AMERICAN COLONY IN BRAZIL*

Mark Jefferson

FIG. 1—Brazilian grandson of a Confederate veteran.

THIS youngster, of unmixed blood of Georgia whites, was born within fifty miles of São Paulo, Brazil, like his father and mother before him and probably speaks the Portuguese of Brazil more easily than the English of the United States. He is a Brazilian and will do his military service in the Brazilian army when he comes of age. I think he counts himself American in spite of his established legal nationality. So do both his parents. The country of his birth may never win his heart. It may be his good fortune later to go away to the States to college for a year or two. He will come back with better English but still English with a Brazilian accent. Brazil cannot be said to have assimilated him. Blood and home associations speak to him of American Georgia as definitely as does the chimney of his father's cottage, singular excrescence on a tile-roofed house in São Paulo; but among the Americans in the hills of Villa Americana all the houses have chimneys and other features incongruous in a Brazilian countryside, such as windows with sliding sashes and wooden shutters, eaves troughs and water conductors, a two-story veranda and a wooden picket fence, as in this house of a neighbor (Fig. 3), a bit of the southern Confederacy set down in Brazil.

EMIGRATION FOLLOWING THE CIVIL WAR

In general the United States has had few emigrants, but Lee's surrender found many in the South unable to endure existence in a country where abolition and the hated Yankee had come out victorious. Lordly men they had been, the wealthier Southerners. With numerous slaves indoors and out to attend their wishes, these men lived like princes. Great numbers of them looked for new homes. Unrest in the South was indeed older than the Confederacy. There were those

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* From field notes of Dr. Alfred Coester, of the American Geographical Society's Expedition to A B C Countries in 1918.

Southerners who had gone into Mexican Texas with their slaves and "kept them still when Mexico, in 1824, abolished slavery." Certainly the end of the war in 1865 turned the eyes of many a last-ditch rebel to Mexico and Brazil, where slaves could still be held.

The government of Brazil had been very keen for their coming. Every Latin American country that has fostered immigration has cherished the illusion that immigrants from the United States might be obtained and has desired them in spite of our little popularity there as a nation. The Latin American countries admire the intelligent capacity for action of our citizens and would gladly incorporate many of them among their own nationals. Their desire proved illusory because none of them ever offered the attraction of the American Homestead Law, while the scale of living of the laboring man in Latin America is far below anything that white men have to put up with in the United States. The defeat of the Confederacy gave Brazil her opportunity. Slavery was not finally abolished in that country till 1888. In Brazil the confederates could have slaves and could also, they thought, grow cotton. It seemed a likely place to continue the old life of the South. Doubtless that was the picture held before Southern families by the agents of the Brazilian government in New York, who contracted with a steamship company for transportation from that point to Brazil and advanced railway fares from points of origin in the Southern states, later shifting the point of embarkation from New York to Mobile and New Orleans.[1]

Captain Richard F. Burton was in Brazil at the time and expected great results to flow from the immigration of Confederates to the Empire.[2] He gives the number of arrivals from the States for 1867 as 2700 persons: 200 in Paraná, 800 in São Paulo, 200 in Rio Janeiro, 100 in Minas Gerães, 400 in Espirito Santo, 100 in Bahía, 70 in Pernambuco, and 200 in Pará, Southerners who had, he says "exchanged their desolate homes for happier regions." The 200 settlers in Paraná were "principally Missourians, who come with considerable capital, and who in a few years will make this centre very important." Captain Burton looked to see a great exodus of "the lower orders of Englishmen, which word includes Irishmen" . . . . "and when Southerners from the United States shall have settled in the Empire, these men, so well accustomed at home to 'drive' whites and to deal with the *prolétaires* and the *colluvies gentium* of Europe, will soon supply the necessary curb."

The outcome has not, however, justified expectations so high. These "unsubmitting Rebels," says Roy Nash,[3] "made small mark upon Brazil, but Brazil certainly put her stamp upon them and their descendants. They had gone to the wrong place." Of the 200 settlers in Pará, near Santarem, there were fifty left in 1874 when Herbert Smith found them, "people from Tennessee, Mississippi, and Alabama who knew how the frontier game should be played; lean, hard men with their wives and children, men who had come to stay." But they were "burdened with debts, living in squalor, with broken-down bodies and discouraged hearts." Now in 1926 "there are not more than twelve or fifteen left, including the second generation! The only North American in that Santarém colony who can be said to have made a success was a man who started with a very considerable capital."[4]

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[1] Compare Lawrence F. Hill: Confederate Exiles to Brazil, *Hispanic Amer. Hist. Rev.*, Vol. 7, 1927, pp. 192–210.

[2] R. F. Burton: Explorations of the Highlands of the Brazil (2 vols., London, 1869), Vol. 1, pp. 5–9.

[3] Roy Nash: The Conquest of Brazil, New York, 1926, p. 152.

The Villa Americana Group

It appears that the group who settled about Villa Americana were among the most successful of all who came to Brazil from the United States. They had started originally for Mexico and had traveled as far as New Orleans when they learned of the death of Maximilian and changed their destination to Brazil.

At first they were landed at Cananea and settled at Iguape, about 100 miles south of Santos in the low country near the coast. In fact two Americans naturalized in Brazil had gone from Iguapé to New York on the government mission to collect immigrants in the States. But the hot, jungly country of the coast did not suit the settlers at all. Within three months the two hundred families that had landed here began to scatter to higher ground. At the end of three years half of them had gone back to North America, and none of them were left near Cananea. At Santa Barbara, on the plateau 70 miles in a direct line northeast of São Paulo, they found conditions to their liking; "better than western Florida or southern Georgia" said one of them. "A white man can work out on the hills in the hottest months. I have done it." This is near the southern border of the torrid zone but at an elevation of 2700 feet above the sea. The hottest month of 1916 showed no temperature at São Paulo as high as 90° with nights in the 60's. Half the time the afternoon temperature failed to rise above 80°, while the winter temperatures rarely fell below 50°.[5]

The Southerners could have slaves, of course, those who had money to buy them, though few did; and they went to raising cotton at once. When the crop was harvested they discovered that there was little demand for cotton, a low price, and no profit in raising it. The older heads of families today admit that they would have done better if they had stayed at home in the States, and the younger people are even more persuaded of it than their elders. Some of them went into the raising of sugar cane and the distillation of "pinga," or rum, for which the market was almost infinite. One at least of the party made a fortune at it.

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[4] *Ibid.*, p. 386.

[5] Mark Jefferson: Actual Temperatures of South America, *Geogr. Rev.*, Vol. 16, 1926, pp. 443–466; reference on p. 456.

Two bits of good fortune came their way: cheap land and an American watermelon. The hills about Santa Barbara had been cleared of forest and cultivated in the manner of Brazilian hoe culture but were now grown up with *sape*, a sort of scrub plant that could not be killed with the hoe. They were therefore regarded as worthless and sold to the Southerners very cheaply. But the plows the Americans brought with them killed the *sape* easily, and the land proved excellent. By this chance the healthful, rolling hills became the site of the farms of the Georgians. One of them likes to tell how he earned the money for his farm by three years labor for a richer neighbor at 25 milreis a month when the milreis was worth 50 American cents. So they did find in Brazil something like homestead land after all. But this mainly enabled them to raise their food and live. There was no money crop until one of them, visiting "back home," brought out some watermelon seed from Georgia that made a wonderful hit in the Brazilian countryside. This must have been about 1878.

At first the Americans took their melons to neighboring towns, where they found ready sale. They were so much pre-

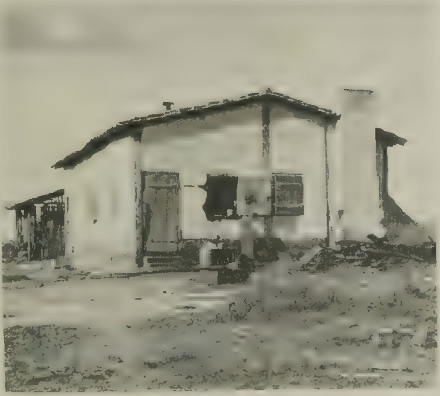

FIG. 2

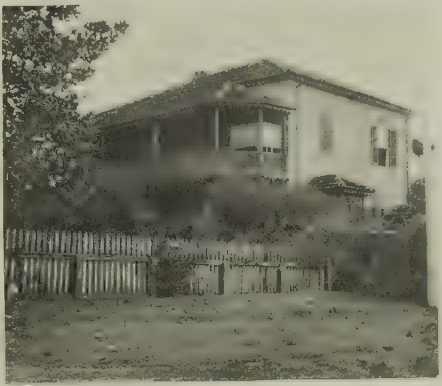

FIG. 3

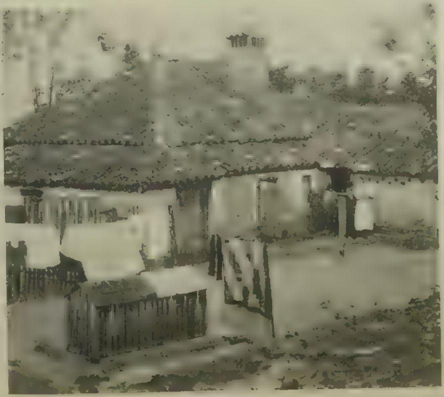

FIG. 4

FIG. 2—Brazilian house with American chimney, Villa Americana.

FIG. 3—"American house" of Dr. Hall, Villa Americana. Note chimney, windows, and shutters.

FIG. 4—House at Villa Americana built by Dr. Pyles' father, mostly with his own hands. Backyard view. Note the chimney and patchwork quilt.

ferred by the Brazilians to their own watermelons that buyers soon began to come to the Americans from far and near. For a season of three months 50 to 100 carloads of watermelons a day were shipped out of Santa Barbara by rail; the broad street near the station was always crowded with carts, and the freight yard was piled high with the crop. One of the Italians who owned land at the station got the name of it changed to Villa Americana. For twenty-five years the business lasted and was the basis of general prosperity for the American colonists. The most profitable period was from 1890 to 1900. Finally the soil became exhausted, and the Italians who had come into the neighborhood took up the business on fresh land. The Americans agree in hating the Italians!

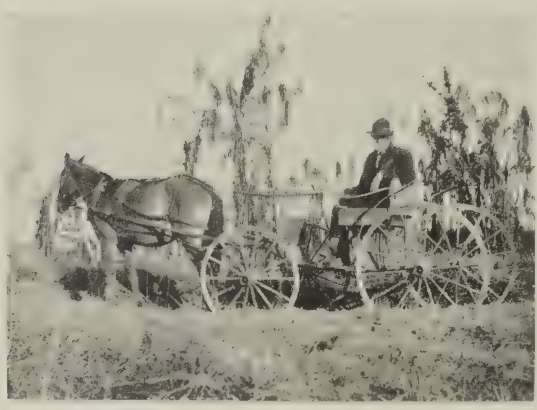

FIG. 5—Veteran settler of 1867 in his buckboard at Villa Americana in 1918. Frost is not common, but that year it killed the bananas.

THE PRESENT SITUATION OF THE COLONY

That has been the only general success registered by the Americans. They raised their food easily enough and something for a money crop but were apt to become Brazilianized, as they put it, which seems to mean lazy, shiftless, and content to get along on little. The colony is not expected to endure. It may be said to be passing away already, for the schools and churches set up by the Americans in the early days to preserve their institutions have ceased to exist. Children are now sent to the States, if the parents can afford it, or to private schools in São Paulo. The Americans feel that the end comes when marriage occurs with Brazilians, for then the children become Brazilians too. But very little of this has occurred in this neighborhood; there were no Brazilians here to marry! The colony will come to an end by scattering to the cities or other parts of the country, where the more capable find opportunities better suited to their capacity. One uncle of our young Brazilian went to Rio Janeiro, where he is regarded as the most eminent surgeon in the city. Another grandson of a Confederate veteran of Villa Americana, in 1918, had just settled up his father's estate, had sold the house, and was leaving to join a brother on a cattle ranch in the western part of Rio Grande do Sul, prosperous in this world's goods but saddened by the unwelcome conviction that he must confess himself a Brazilian. He had been to the States in the attempt to establish American citizenship and had been denied it.

The only Brazilians the Americans of Villa Americana came in contact with are of so low a social stratum that Brazilian is a word of contempt in the colony, much as it is at Joinville.[6] The operation of the "melting pot" that has transformed so many European peasants into new men in the United States has been opportunity to rise above a previous lowly condition. This was provided in the United States by free homesteads and opportunity in trade and industry. By continuous application of the habits of thrift and industry they brought with them the European peasants rise with relative certainty to a condition above anything the old world can offer them, and their contentment with their new home grows. The American colonists in Brazil found no such novel opportunity. Economically and socially they had been better off in Georgia than most of them ever were in Brazil. In fact only the two happy circumstances mentioned had saved them from the misfortunes that attended most of the parties of Americans. For the rest Brazil offered them only slavery—until 1888—and slavery proved no panacea. It does not appear to have been of any use to them, though they gave up much to secure it. Brazil, on the other hand, gained from their coming in their immediate localities. Of this the plow factory at Villa Americana in a hoe-culture countryside is an evidence. The infusion of American blood in the Brazilian race was worth while too, but both items are small in the vastness of Brazil.

It does not appear that the Americans greatly influenced their fellow colonists, the Italians, except in breaking the *sape* with the plow and the culture of the watermelons. There was little social contact. The buckboard, admirably adapted to this rough country, is still in use by the Americans but has not been adopted by their neighbors. But in the cities to which the Americans mostly drift they add a most desirable element to Brazilian society into which they are likely to be promptly amalgamated.

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[6] Mark Jefferson: Pictures from Southern Brazil, *Geogr. Rev.*, Vol. 16, 1926, pp. 521–547.

EXPLORATION OF THE WATERS OF THE GULF OF MAINE

Henry B. Bigelow

Museum of Comparative Zoölogy, Cambridge, Mass.

THE warm, sapphire-blue Gulf Stream with its tropical freight, on the one hand, and the receding coast lines of Nova Scotia, Maine, and Massachusetts on the other, enclose the cool, green waters of the Gulf of Maine. Partially enclosed by the Banks, Georges and Browns, that form its shallow offshore rim and largely protected from the tropic water it faces by the peculiar distribution of densities along the arc of its seaward front, the Gulf is a sort of backwater from the Atlantic. Here the cod, haddock, pollock, herring, and all the other fish that make up the 400-odd-million pounds of sea food it yields to man every year play their rôles, inured to seasonal fluctuations but seldom suffering any fatal variation in temperature.

The Gulf may well be named a "promised land" for its inhabitants; it is equable in climate and moderate in salinity; its deeps are constant from season to season; and it is well supplied with food, whether animate or dissolved. In all of which our Gulf is comparable with the North Sea across the Atlantic.

No doubt for this very reason, because it is less spectacular than the Gulf Stream across its offshore portal, less stirring to the imagination than the ocean abyss, none of the major deep-sea expeditions have so much as entered the Gulf of Maine. The earlier collecting expeditions of the U. S. Bureau of Fisheries, in the seventies and eighties of the past century, did, it is true, record serial temperatures in its western side in summer. However, knowledge of the saltness of its waters; of their temperatures at other times and places; of their dominant circulation; and of the plankton they support, might still be hazy but for the growing appreciation that it is in the shoaler seas and in moderately high latitudes that the physical, chemical, and biologic problems most vital in the life chain in the sea are best attacked.

The study of marine ecology in the modern sense, which first gathered momentum in northern Europe under the auspices of the International Committee for the exploration of the sea, has now become widely extended. In the summer of 1912, as a step in its progress, the Museum of Comparative Zoölogy and the U. S. Bureau of Fisheries in coöperation began a detailed exploration of the oceanic biology and physical oceanography of the offshore waters of the Gulf of Maine.

This preliminary survey may now fairly be described as completed with the publication of the final part of the general report, making timely a brief summary of the progress of the undertaking and of its more directly geographic results.[1]

The value of any such study of a given part of the sea depends very largely on the thoroughness of the exploration. It was realized from the beginning that all seasons of the year must be covered, since seasonal fluctuations would be wide, both in the temperature and salinity of the water and in its biology. Equally, the survey must be extended over a considerable period of years (at least at certain places) to take account of the annual fluctuations which there was every reason to expect. And it was obvious that, for an understanding of the internal problems of the Gulf, the state of the coastal waters to the east and west of it and of the inner edge of the Gulf Stream offshore, must also be examined. But it was necessary to begin on a small scale, increasing our modest outfit, and extending the cruises in duration from year to year, as the increasing significance of the scientific harvest seemed to warrant.

Our work has consisted mostly in the taking of serial records (surface to bottom) of the temperatures and of the salinity of the water; combined with an extensive program of tow nettings, shoal and deep, at stations scattered netlike over the Gulf and so placed as to yield both horizontal projections and a variety of profiles.

The Temperature of the Water in the Gulf of Maine

Of the several physical features of the sea water, its temperature is the most important biologically, for this determines what general communities of animals (plants in less degree) can survive in any particular part of the ocean, granted that such other factors as light, food, salinity, alkalinity, etc., favor their existence.

The temperature of the water in any part of the sea is controlled by the interplay of two processes. One is the transport thither of warm water or of cold from elsewhere by the flow of ocean currents, which may raise the local temperature above the mean for its latitude, as happens along the coasts of northern Norway, or chill it below, as in the Labrador Current skirting southward past Newfoundland and the Grand Banks. The other factor is the interaction between solar warming *in situ*, on the one hand and cooling by evaporation and radiation on the other.

It has long been known that the Gulf is boreal in temperature, its mean surface value (which we can now set at about 7° to 8°) being several degrees lower than the mean for the Atlantic as a whole at its latitude (between 13° and 14° C.). To this we can add that a much greater discrepancy of the same sort prevails between the deeps of the Gulf—100 meters and deeper—and the corresponding depth zone of the open oceans at the same latitude. Until the present exploration was undertaken it was the generally accepted belief that the Gulf of Maine owed its low temperature directly to an Arctic current. Perhaps the most instructive result of the cruises has been the demonstration that this is not the case. Although cold water from a more northern source does pour into the Gulf from the east every spring, it is the local influences just mentioned, combined with an indraft of water over the bottom from the edge of the continent, that chiefly determine the local temperature.

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[1] *U. S. Bureau of Fisheries, Bull. 40.* Preliminary accounts of the work have appeared from time to time in *Science* (Vol. 38, N. S., pp. 599–601) and in the Bulletins of the Museum of Comparative Zoölogy (Vol. 58, 1912, pp. 31–144; Vol. 58, 1914, pp. 383–420; Vol. 59, 1915, pp. 149–360; Vol. 61, 1917, pp. 161–358; Vol. 65, 1922, pp. 85–188.

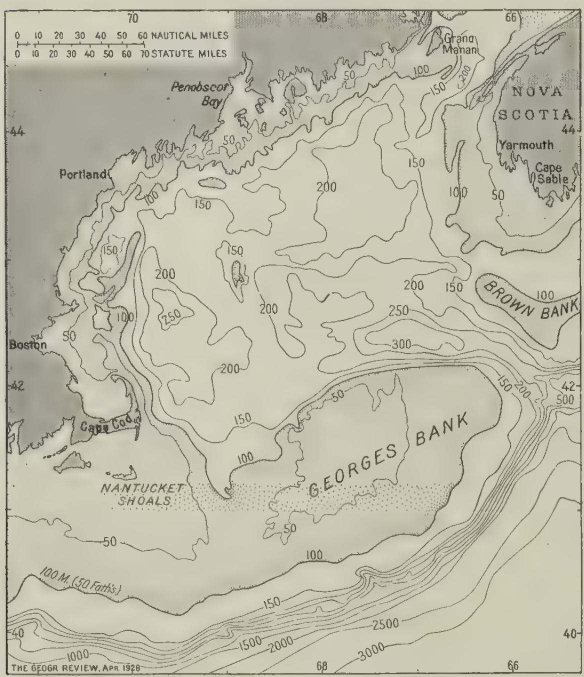

FIG. 1—Bottom contour of the Gulf of Maine, based on Hydrographic Office Chart 941. Depths in meters.

Thus if the Gulf may seem to lose interest from one point of view, it gains from another, as offering an opportunity to trace the seasonal alterations which follow potent solar warming during the warm months, alternating with a rapid loss of heat by radiation during the cold. Equally instructive has been the correlation between areas of cold surface and of violent tidal churning, for it is where the latter is most active that the supply of dissolved foodstuffs is most constantly renewed in the upper stratum, making conditions most favorable for marine plants and, in turn, for the animals that feed thereon. Evidence of this appears in the concentration of the "sardine" sized herring in the tide-swept and homogeneous waters of Passamaquoddy Bay and among the islands along the eastern sector of the coast of Maine.

On the chart the Gulf of Maine is simply an open bight. But when the contour of the bottom (Fig. 1) is taken into account it becomes a far more definitely limited area, for its ocean front takes the form of a rim (Nantucket Shoals, Georges and Browns Banks) so shoal that at a depth of 100 meters the basin of the Gulf within is entirely enclosed except for two narrow passages. These are the Eastern Channel, opening to the southeast between Georges and Browns Banks, and the shoaler Northern Channel, lying between the latter and the coastal slope of Nova Scotia. Topographically, then, the Gulf may without much exaggeration be considered mediterranean, or landlocked. Whether the water within a bowl of this sort be colder than off its mouth, as is the case in the Gulf of Maine, or warmer, as in the Red Sea, depends on the local thermal determinants. In the Gulf of Maine we have a low temperature due to winter chilling plus cold water from the north and east, contrasted with almost tropic temperatures offshore. How effectively the rim actually separates the deeper strata of the bowl on the one hand from the inner edge of the Gulf Stream on the other may be illustrated by the summer profile of temperature, running out from the offing of Cape Cod, southward across Georges Bank (Fig. 2). While the surface of the western side of the Gulf may warm, under the summer sun, to a value approaching that of the tropic water offshore (18°–20°), to find temperatures over the continental slope as cold as is the 100-meter level within the Gulf (4°–5°) it is necessary to sink deeper than 500 meters, i. e. down almost to the upper boundary of the nearly homogeneous water of the oceanic abyss. So abrupt a transition between low temperatures on the continental shelf and very much warmer temperatures only a few miles offshore all along the northeast American seaboard to the Grand Banks, even where there is nothing in the contour of the bottom to prevent interchange in the one direction or in the other,

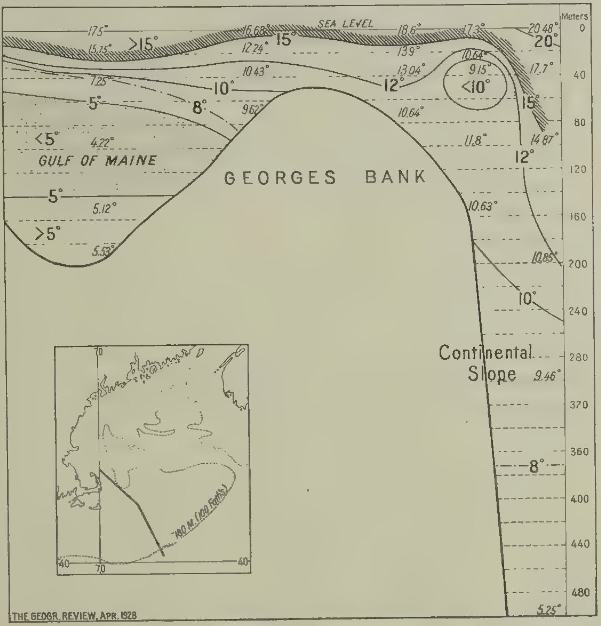

Fig. 2—Profile of temperature, running from a point off northern Cape Cod southeastward across the Gulf of Maine, Georges Bank, and the Continental Slope, for July 19–21, 1914.

has no counterpart in northern European waters. The nature of the boundary which holds apart these warm and cold waters—for a boundary, even if invisible, there must be—is a problem of great general interest.

In valuing the geographic significance of the temperatures of the Gulf of Maine, we must bear in mind its situation to leeward of the continent. Disturbances of the atmosphere, cyclonic and anticyclonic alike, move from the land out over the sea here; the reverse is the rule in Europe where land draws from sea. *A priori* then we might expect any partially enclosed basin at a moderately high latitude off the American coast to reflect the rigorous continental climate to the west of it. It is a rapid absorption of heat from spring to summer from solar warming, not a general overflow of the Gulf Stream from offshore, that we find reflected in the high summer temperature of the surface of the western part of the Gulf of Maine (Figs. 2 and 3).

Though a seeming paradox, it is equally this rapid heating of the surface by the sun that causes the continuance of low temperatures in the deep strata of the Gulf throughout the summer. Sea water is so comparatively opaque to solar radiation, of the wave lengths that carry most of the sun's energy, that the direct effect of the latter is expended close to the surface. As the surface warms, with little change in the deeper strata, the water column tends to become increasingly stable vertically. Unless this process be effectively combatted by strong tidal stirring, the underlying water becomes blanketed against thermal influences from above; the cold of the preceding winter is preserved into autumn; and summer temperatures as low as 4°–5° at a depth of 150 meters, or even at more moderate depths, are found in general over the western side of the Gulf of Maine.

The efficacy of thermal insulation of this sort depends chiefly on the local activity with which the tides stir the water. Where these run strong over irregular bottom or among islands, with active upwellings and overturnings that bring cold water constantly up from below and carry warmer surface water down, the solar heat is more evenly distributed. In such places the surface continues cooler through the summer, but the underlying strata warm more rapidly than elsewhere in the Gulf. The most notable local example of this is in the Bay of Fundy region in general, and in Passamaquoddy Bay in particular, where a cold surface in summer (10°–12°), long taken as evidence of an Arctic current, is now known[2] to reflect tidal churning so active that the sun's heat is spread through the whole upper 50 meters of water, instead of being absorbed by the upper 10-20 meters. Consequently, the water down to this depth is kept practically of that same temperature, even at the warmest season, when the bottom is warmer there than in Massachusetts Bay, though the surface is 8° or 9° colder. As a result of these local variations animals of subarctic affinity find a more favorable environment—i. e. lower temperature—in the deep water off Massachusetts Bay, and especially in certain partially enclosed sinks there, than anywhere in the opposite side of the Gulf. On the other hand, the considerable category of boreal animals confined to temperatures cooler than 12° or so must keep to deep water in the western side of the Gulf during the summer months; but in the Bay of Fundy they can live right up to tide line. This is another reason why the northeastern part of the Gulf has sometimes been loosely described as "arctic" in character.

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[2] By observations by the Biological Board of Canada.

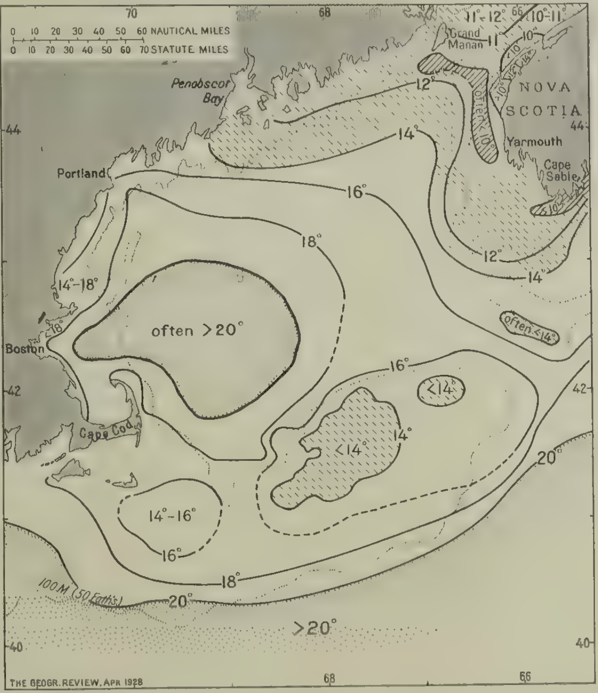

FIG. 3—Normal temperature at the surface of the Gulf of Maine for the last half of August, based on a combination of the available data.

The surface is also kept cold, by tidal stirring, along western Nova Scotia. Other areas of cool surface, similarly caused, and outlined on the chart (Fig. 3), are on the shallows of Georges Bank and on Nantucket Shoals, where the whole column is practically homogeneous surface to bottom, at summer temperatures varying locally from 12° to 14°. And the fact that the difference in mean summer temperature between Nantucket Shoals on the one hand and Passamaquoddy Bay on the other is no greater than their difference of 3½ degrees of latitude would call for is one of the many links in the chain of evidence that "arctic" is wholly a misnomer when applied to the cool surface of the northeastern part of the Gulf of Maine in general or of the Bay of Fundy in particular.

In summer, local upwellings of cool water often chill the surface close along the western coast of the Gulf when the wind blows offshore, a fact with which every bather is familiar. By this means the surface in Massachusetts Bay is usually kept some two degrees cooler (less than 18°) in the coast strip between Boston and Cape Ann, than it is offshore (more than 18°). On the Nova Scotian side, however, whatever water may be brought up by such upwellings has about the same temperature as that which it replaces; and so is not made evident by its temperature.

The combined effect of these vertical movements of the water, balanced against local solar heating, is that the surface warms to the highest temperature over the deep basin in the offing of Massachusetts Bay (18°–20°), with a general west-east gradation to 10°–12° in the opposite side of the Gulf, as outlined on the chart (Fig. 3).

In most summers (not, however, in all) the Gulf is coldest in the mid-depths, at 100–150 meters (4°–5°), and is some two degrees warmer on the bottom of the basin at 175 meters and deeper. In this case it is clear enough that a cold layer of this sort reflects nothing more than the depth to which the previous winter's chilling penetrated, just as does a similar vertical distribution of temperature in the Baltic or the Black Sea. And the presence of a mass of warmer water underlying it, not only comparatively uniform in temperature but so saline as to be high in specific gravity, is direct evidence of an indraft over the bottom from offshore. This indraft must enter via the deep Eastern Channel, this being the only source from which the supply of water of this particular character could be maintained against its constant consumption by the various mixings of the water in the inner parts of the Gulf.

The surface of the Gulf, as a whole, is at its warmest in August. After the first of September the surface of the western side cools: first, by simply mixing with the colder water below as the absorption of solar heat decreases; next, through an actual loss of heat by radiation into the cooler overlying air. But as it is not until a month or more later that these changes affect the cooler surface of the eastern side, the regional differences in surface temperature decrease, until, by mid-autumn, the whole surface of the Gulf is in most years nearly uniform at 9.5°–10.5°, varying only a degree or two one way or the other from place to place. In 1915, a typical year, this state was attained between the first and middle of October. As the surface cools, vertical stability decreases, allowing tides, wave action, etc. more and more freely to bring up water from below to radiate out its heat to the air. At the same time and by the same process of mixture the mid-strata are warmed, so that the 40-meter level, off Massachusetts, is not at its warmest until October; the 70-meter level not until November, the 100-meter level not until early in December (Fig. 4). Thus the notable thermal stratification, characteristic of most parts of the basin of the open Gulf in summer, gradually gives place to a close approach to vertical homogeneity by the end of autumn at an average value close to 8°. For the upper

100 meters winter chilling is so rapid from that date onward that by the middle of February the upper 40 meters around the whole margin of the Gulf has chilled below 2° (Fig. 5): fractionally below 0° in Cape Cod Bay, where more or less ice alternately freezes and melts, and locally in the bays along the coast of Maine and of the Bay of Fundy.

Wherever winter chilling of the sea follows cold winds blowing out from the land, the water is coldest next the land. The Gulf of Maine is no exception; its surface temperature rising offshore to 3°–4° over the southern half of the basin, 3°–5° on Georges Bank, at the coldest season (February). Furthermore, the water is then coldest at the surface (Fig. 4), not warmest as it is in summer. Though the loss of heat is so rapid from the surface, the resultant cooling penetrates down only to a depth of about 100–150 meters during each winter. Deeper than this the temperature of the Gulf varies only a degree or two either way, from 5° to 6°, throughout the year or from year to year. Thus animals dwelling on bottom must be prepared to resist a seasonal variation of more than 16° in temperature if near tide mark; and if not able to survive temperatures close to the freezing point of fresh water, or even lower, they there run the risk of widespread destruction, such as sometimes befalls cunners and other fishes if overtaken in some shoal harbor by a sudden freeze. By swimming down a few fathoms deeper, as many fishes do, they can escape this risk.

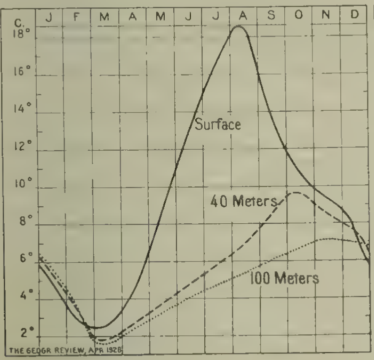

FIG. 4

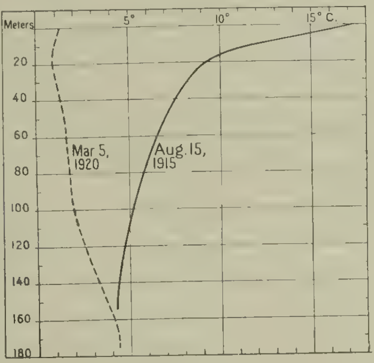

FIG. 5

FIG. 4—Normal seasonal progression of temperature at the mouth of Massachusetts Bay, based on a combination of the records from the several years of record.

FIG. 5—Temperature in the trough off the Isles of Shoals August 15, 1915 (solid curve), and March 5, 1920 (broken curve).

In the Gulf of Maine, as in any lake or pond, winter chilling gives place to vernal warming from the date when the mean temperature of the air rises above that of the water. In the western and northern parts of the Gulf as a whole, this happens, in average years, about the end of February. And in this general subdivision of the area the process leads directly to the summer state of high stability and of notable thermal stratification just pictured. In the eastern side, however, it is annually interrupted and may even be temporarily reversed by an inrush of icy water past Cape Sable from the eastward. This event falls earlier in some years than in others, our experience suggesting late March to late April as covering the period within which it is at its maximum in normal years. At this time water from this eastern source may chill the surface of the Gulf to 0° as far westward as longitude 67° 30′; such was, in fact, the case in 1919. But in all the years of record this drift has involved solely the upper stratum, shoaler than about 100 meters; and it has appreciably chilled the temperature of the Gulf for only a brief period, apparently synchronizing with the melting of ice far to the eastward.

When the flow from the east past Cape Sable diminishes, the icy water so brought to the Gulf is so soon thoroughly incorporated with the warmer waters it meets there that in most years the regional disturbance of temperature it at first effects is entirely obscured by June. After that month whatever surface water enters the eastern side of the Gulf from the offing of Cape Sable acts as a warming, not as a chilling agent, being 1–3° warmer than that with which it mixes to the westward of the Cape.

The most interesting question regarding this contribution to the Gulf from the east and northeast is, to what extent is its low temperature reponsible for the boreal character of the latter? Would the Gulf be considerably warmer without it? We cannot escape the conclusion that with the cold water flooding past Cape Sable every spring in considerable volume, the Gulf of Maine into which it enters must be cooler than it would if this supply were dammed off. But if this Nova Scotian contribution did cool the surface more than a degree or two below the value that would result from winter chilling alone, the mean temperature of the upper 40 meters would run considerably lower in the eastern side of the Gulf, into which it debouches, than in the western; whereas the regional difference in this respect is actually no wider than is called for by the difference in latitude. Nor does it appear, from a comparison with the deep Norwegian fiords and with the Black Sea, that the mean annual temperature even of the coldest stratum in the Gulf is lower than might be expected in an entirely enclosed body of water in the same geographical situation, being only 1°–3° lower than that of the overlying air.

Even, however, if this Nova Scotian current does not lower the temperatures of the Gulf of Maine, generally, more than a degree or two below the values which would prevail there were the Gulf closed to exotic waters, cold or warm, the comparatively high temperatures (6°–8°) of the current flowing into the bottom of the Gulf and of the surface water entering in summer would hold the Gulf temperature considerably higher than is actually the case, were it not for the Nova Scotian current. And it is in combatting these sources of heat that the cold water from the east plays its chief thermal rôle in the Gulf of Maine complex.

Although it may now be accepted as definitely established that the waters of the Gulf of Maine, and of the coastal belt thence westward, can no longer be described as an "arctic" countercurrent (an explanation one may see in almost any one of the older textbooks), the nature of the icy water that undoubtedly does reach the Gulf by the route just mentioned deserves a word, because it is only within the past few years that its source has been definitely established.

Of old the responsibility was generally laid to the Labrador Current, of ill repute; perhaps without much analysis, and certainly without much actual evidence. For the Labrador Current to reach the Gulf of Maine would entail a general drift southwestward from the region of the Grand Banks, to cross the oceanic triangle separating the latter from the Scotian Banks. But actual explorations of that general area—begun with Schott's[3] study of the circulation of the Grand Banks region, continued by the Canadian Fisheries Expedition of 1914,[4] by the Biological Board of Canada, and by the surveys carried out yearly by the International Ice Patrol since 1914[5]—have reported no evidence of any such drift either in the temperature or salinity of the water or in the movements of the ice. So careful a record has been kept, by the Patrol, of the drifts of the bergs that come south with the Labrador Current and so thorough a survey of temperatures has been made at the season when the Arctic flow is at its maximum that any direct continuation of the latter toward Nova Scotia or the Gulf of Maine could hardly have escaped notice. It is also to the point that the cold current that skirts southward along Nova Scotia in spring and early summer is much less saline than the Labrador Current. It is separated, too, from the latter by much higher salinities (as well as temperatures) over the intervening deep.

Without delving further into the mass of evidence available elsewhere, it is established that the Labrador Current is hardly recognizable as a definite ocean stream more than a few miles south or west of the tail of the Grand Banks. On this, observers who have studied the Grand Banks region at first hand are unanimous. Certainly this current does not reach the coasts of Nova Scotia or of New England as a regular event, except indirectly via the Gulf of St. Lawrence or via the slope water and robbed en route of its thermal characteristics.

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[3] Gerhard Schott: Die Gewässer der Bank von Neufoundland und ihrer weitern Umgebung, *Petermanns Mitt.*, Vol. 43, 1897, pp. 201–212.

[4] Paul Bjerkan: Results of the Hydrographical Observations Made by Dr. Johan Hjort in the Canadian Atlantic Waters during the year 1915, Canadian Fisheries Expedition 1914–15 (1919), pp. 349–403, Dept. of the Naval Service, Ottawa.

W. J. Sandström: The Hydrodynamics of Canadian Atlantic Waters, *ibid.*, pp. 221–343.

[5] See the annual reports of the International Ice Observation and Ice Patrol Service, *U. S. Coast Guard Bulls.*

To some extent the cold of the drift that reaches the Gulf of Maine past Nova Scotia and Cape Sable mirrors the generally low vernal temperatures of the discharge from the Gulf of St. Lawrence around Cape Breton—a current long known either as the "Cape Breton" or as the "Cabot" which in its flow reflects the enormous volumes of fresh water draining into that Gulf. But it is the melting of the ice which this current brings out of the latter in spring that is more directly responsible, for in its dispersal and disintegration this annually develops an icy pool in the region of Misaine and Banquereau Banks. From this, in turn, the combined records of the Canadian Fisheries Expedition, of the Ice Patrol, and of our own cruises show a tongue-like extension to the west, nearly to Cape Sable in the spring of 1915 (Fig. 6). And much evidence to this same effect has subsequently been accumulated, especially from the many series of drift bottles put out by the Biological Board of Canada.

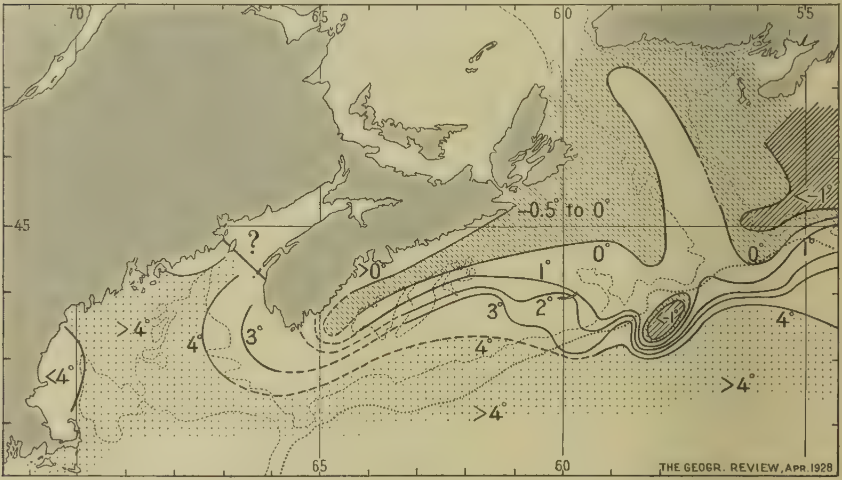

FIG. 6—Distribution of the coldest water in the upper 300 meters irrespective of depth, in May, 1915, based on data gathered by the Canadian Fisheries Expedition and by the *Grampus*.

A question of considerable interest to the biologist as well as to the oceanographer is how far to the westward the thermal effect of this cold Nova Scotian drift can be followed. This cannot yet be answered, categorically. But to it, directly or indirectly, is almost certainly due the low temperatures of the cold bands that have often been recorded just outside the edge of the continent in the offing of Nantucket. One such was traced along Georges Bank from the northeast to southwest in July, 1914. Phenomena of this sort have been reported often enough to show that a movement of cold water takes place annually, in this direction, at least to longitude 69°, during the late spring or first days of summer. In summers when this drift is greatest in volume, or lowest in temperature, it may even maintain temperatures as low as 5° along the slope of Georges Bank at about the 100-meter level into July, as was the case in 1916. This, however, is shown by our experience in other years to have been unusual.

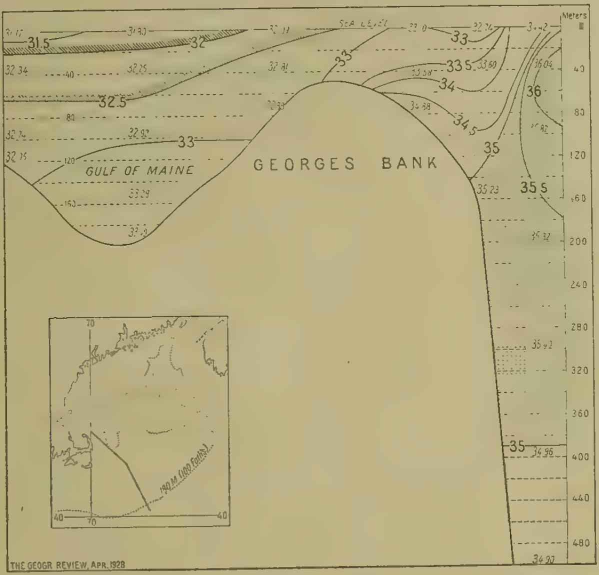

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FIG. 7—Profile of salinity, running from a point off northern Cape Cod southeastward across the basin of the Gulf of Maine, Georges Bank, and the Continental Shelf, for July 19–21, 1914.

THE SALINITY OF THE GULF OF MAINE

During the last quarter century the view, once prevalent, that small variations in the total saltness of the sea water governed many vital phenomena in the sea has given place to appreciation that more significant in marine ecology are the variations in individual solutes, so dilute that their widest fluctuations make only very minor differences in the total salinity. To the physical oceanographer, however, the degree of salinity of the water is of the greatest interest, because of the light it throws on the sources of the waters concerned and because it is one of the two factors that determine the specific gravity of the water and consequently govern its dynamic circulation.

The Gulf of Maine, according to our many determinations, falls among the less saline of enclosed seas. It is much less saline than the North Sea, more so than the Baltic, but does not much differ from the Skagerrak which connects these two. On our own side of the North Atlantic it finds a parallel in salinity in the Gulf of St. Lawrence, whose waters are about as saline as those of the Gulf of Maine in the deep strata but slightly less so at the surface.

Taking one season with another, the surface of the Gulf of Maine, out to its offshore rim, averages about 32–32.5 per mille in salinity; the 100-meter level, typical of the mid-depths, 32.8–33 per mille;

the bottom, at 175 meters and deeper, 33.7–35 per mille. These values fall far below those of the Gulf Stream off the mouth of the Gulf of Maine; and the contrast is as abrupt in salinity along the edge of the continent (Fig. 7) as it is in temperature (Fig. 2).

Perhaps the most interesting aspect of the salinity of the Gulf is the wide regional variation in its inner parts. The recorded range in spring, when this is at its maximum (from less than 28 per mille to slightly more than 35 per mille) covers a range wider than that of the whole Atlantic basin outside the 1000-meter contour but closely corresponds to that of the North Sea and Skagerrak combined. As might be expected, the Gulf is invariably least saline around its periphery, where it is affected by its tributary rivers. However, we did not find it saltest along its offshore rim, as the close proximity of the Gulf Stream only 20–40 miles away led us to expect, but along a rather definite tongue, penetrating inward from the edge of the continent through the deep channel between Browns and Georges Banks and so northward toward the offing of the Bay of Fundy, there to swing westward parallel to the coast about as far as the longitude of Penobscot Bay. This distribution has appeared repeatedly on the charts of salinity for the mid-levels (Fig. 8); less clearly at the surface where it is obscured by the active stirring of the water.

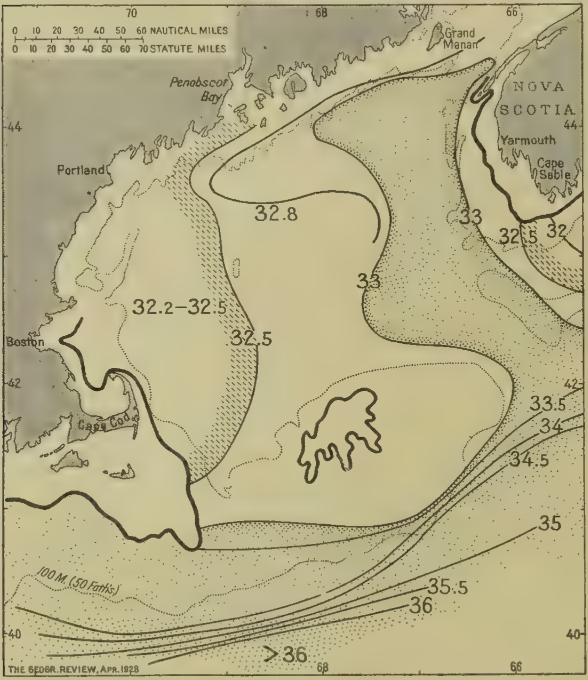

Fig. 8—Salinity at a depth of 40 meters, July–August, 1914.

A wide seasonal variation is to be expected in the salinity of the uppermost stratum in northern seas, the basins of whose tributary streams are largely frozen and snow-covered in winter, with the streams in freshet when the snow melts and the ice goes out of stream and lake. This is illustrated in the Gulf of Maine by a sudden freshening of the surface around the margin in spring (Fig. 9) followed by a progressive salting as the inrush of river water is gradually incorporated by the various circulatory movements already mentioned.

The maximum seasonal range of salinity so far recorded for any one station in the Gulf is in the Bay of Fundy, from a minimum surface value of about 28 per mille in May to a maximum surface salinity of about 32.7 per mille at the end of winter. This, with maximum of slightly more than 32 per mille and minimum of 28.3 per mille at the surface off the Merrimac River, suggests a seasonal variation of at least 4 per mille as usual for the surface along such sectors of the coast line as are most affected by land water. In the central parts of the Gulf, however, the maximum seasonal range yet recorded has been only from about 31.6 to about 33 per mille; i. e. less than half as much as next the land. And even where vernal freshening is most pronounced it is chiefly restricted to the upper 40 meters, the widest seasonal variation so far recorded at a depth of 100 meters being only about 1.2, while in the trough of the basin, deeper than 175 meters, the salinity continues virtually constant throughout the year and from year to year.

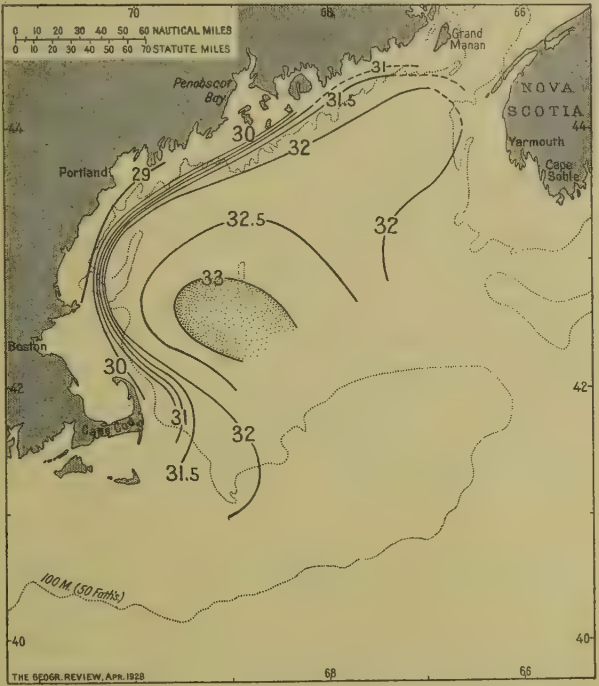

FIG. 9—Salinity at the surface for the first half of May, from the data for 1915 and 1920 combined.

Not less characteristic is the fact that throughout the spring and summer a very considerable vertical range of salinity prevails over most of the area of the Gulf, with the surface freshest and the bottom the most saline. The only exception is that where the water is most thoroughly churned by the tides, as it is in the region of Passamaquoddy Bay, the column is kept nearly homogeneous in salinity, from surface to bottom, just as it is in temperature. This vertical range rules widest in spring and summer, when the surface is least saline; narrowest at the end of winter, when the upper 40 meters is as nearly homogeneous in salinity as in temperature, though even at that season the deeper strata show the salinity increasing with depth. Typical salinity gradients for the basin of the Gulf, winter and summer, are reproduced in Figure 10.

The events in the salinity cycle mentioned so far are bound up with fluctuations in the amount of land water entering the Gulf, either locally from its tributary streams or as a constituent of the Nova Scotian drift. In the deeps of the Gulf, however, the precise salinity and its regional variations reflect the varying pulses in the inflowing bottom current and the track followed by the latter.

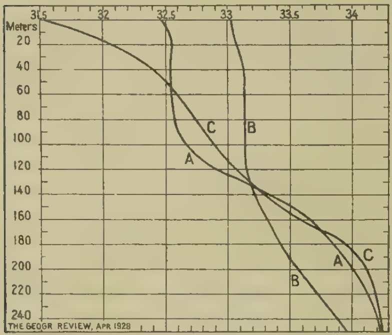

FIG. 10—Vertical distribution of salinity in the basin of the Gulf of Maine in the offing of Cape Ann, March 24, 1920 (A); May 5, 1915 (B); and August 22, 1914 (C).

Along the floor of the Y-shaped trough, in depths of 175 meters and more, this supply is sufficiently constant to hold the salinity close to 34 per mille year in and year out. But in isolated bowls equally deep much lower salinities may prevail if the rim rises high enough above the general level of the sea floor to hinder overflows by the heavy bottom water.

A bowl of this type some 15 miles off Gloucester, with maximum depth of 99 fathoms (181 meters) and a rim rising (at its deepest point) to within 39 fathoms (about 71) meters of the surface, was for this reason chosen as one of our standard observing stations. Here the shoal rim so effectively prevents interchange of water, at greater depths, that we have invariably found the bottom of the bowl considerably less saline than the corresponding stratum of the open trough of the Gulf near by (the differential has ranged from 0.4 per mille to 1 per mille) and vertically homogeneous, instead of showing the salting with increasing depth that is generally characteristic of the bottom water of the Gulf.

Lower rims less effectively divert the inflowing bottom drift from the Bay of Fundy (salinity at 175 meters close to 33 per mille within, 34 per mille outside) and from the deep trough enclosed between Jeffreys Ledge and the mainland.

THE CIRCULATION OF THE GULF OF MAINE

As our outlook broadens on the forces that set currents in the sea in motion, it becomes increasingly probable that its every part is the seat of a dominant movement of the water in one direction or another, enduring over periods longer than that of the tidal oscillation. Where tides run strong, these may prevent recognition of the underlying circulation. Until its systematic exploration was undertaken, this was true of the Gulf of Maine. Even at an earlier date, however, a dominant set to the southeast, past Cape Cod and the region of Nantucket Shoals, had been recorded at numerous localities by the U. S. Coast and Geodetic Survey (Fig. 11). And Mavor's[6] recent analysis of current measurements taken in the eastern side of the Gulf by the Tidal Survey of Canada, under the direction of Dr. W. B. Dawson, has shown a still more pronounced non-tidal component, setting northerly along the Nova Scotian shore, into the southern side of the Bay of Fundy and out of its northern side.

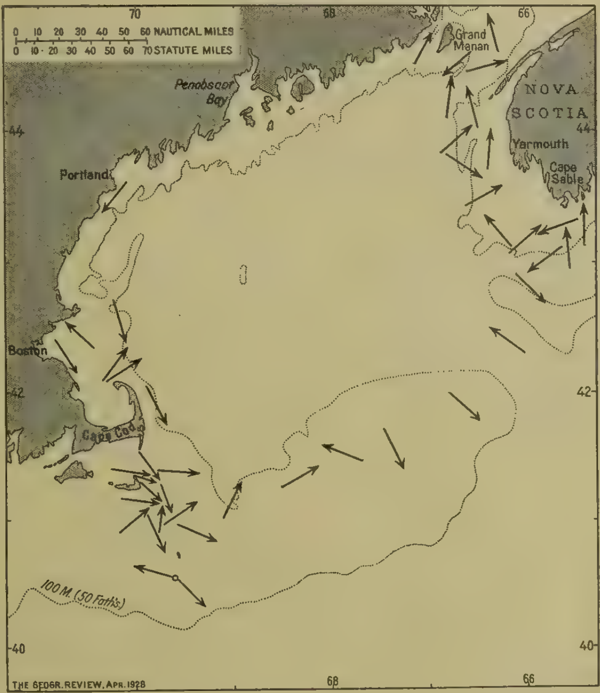

FIG. 11—Direction of the dominant current at stations of the U. S. Coast and Geodetic Survey, of the U. S. Bureau of Fisheries, and of the Tidal Survey of Canada. The arrows swim with the current.

These together point to an anti-clockwise type of circulation around the coast line of the Gulf of Maine. And, as our observations on the temperature, salinity, and plankton of the Gulf have accumulated, it has become increasingly apparent that the Gulf as a whole is in fact dominated by a rather definite movement of this sort. The existence and prevalence of this "Gulf of Maine" eddy, is most clearly revealed by the regional variations in salinity. The open ocean off its mouth is its only possible source for water of very high salinity, while low salinity as clearly reveals the lines of dispersal of river water. Consequently the saline entrant tongue in the eastern side, just described (Fig. 8), is direct evidence of a current from offshore inward around the eastern side of the basin of the Gulf, with the successive isohalines outlining its continuation westward and southwestward around the northern side. On the other hand, the evident tendency of the freshest water—especially at the season when coastwise salinity is lowest—is not to fan out off the mouths of the great rivers, as would happen were there no longshore tendency in the one direction or in the other, but to hug the land (Fig. 9), positive evidence of a general movement parallel with the coast. This is one of the most interesting phenomena in the hydrographic cycle of the Gulf.

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[6] J. W. Mavor: The Circulation of Water in the Bay of Fundy, Part I: Introduction and Drift Bottle Experiments, *Contribs. to Canadian Biol.*, Vol. 1 (N. S.), 1922, pp. 103–124.

In the mid levels, where the Gulf is entirely enclosed except for the narrow channels that pierce its southern rim, the regional distribution of salinity—highest in the eastern side—equally points to an anticlockwise movement of the water (Fig. 8).

Salinity is also a good index to the lines of dispersal of the Nova Scotian current in the Gulf, by the freshening of the surface effected by it. It would equally disclose any overflows by the Gulf Stream, should such occur.

Dislocation of the isotherms likewise follows the westward flood of icy water past Cape Sable in spring and therefore discloses it when the temperatures are charted. Otherwise temperature is not so trustworthy an index as is salinity to the dominant movement within the Gulf, because of the rapidity with which the water may warm by solar heating or may cool by winter chilling, etc. Hence this phase may here be passed over with the remark that many more or less disconnected bits of thermal evidence combine to corroborate the evidence of salinity and to prove the prevalence of the Gulf of Maine eddy.

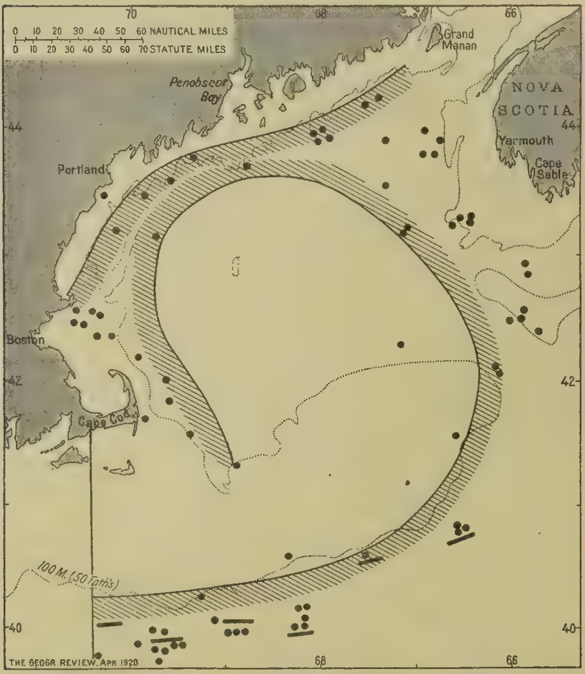

FIG. 12—Locality records for certain of the most typical oceanic immigrants of tropical origin, short-lived in the lower temperatures of the Gulf of Maine, including Salpae, Euphausiids, Copepods, Siphonophores, Sargassum. (For more detailed chart see *Bull. Bur. of Fisheries*, Vol. 40, Part II, p. 53, Fig. 31.)

The geographic distribution of the various planktonic immigrants which, from time to time, visit the Gulf of Maine, affords equally instructive evidence of their lines of drift and for two reasons. First, they come from diametrically opposed sources—tropicals from the

Gulf Stream, arctics from the icy Nova Scotian current of spring. Second, certain of them are so short-lived within the Gulf—the one category finding its waters too cold, the other too warm—that their occurrence at any station is sure evidence of a movement of water thither, shortly previous, from outside. On plotting the recorded capture of these ephemeral visitors, tropics (Fig. 12) and arctics together, they all have proved to be concentrated in a rather definite zone, extending inward from the Eastern Channel and Browns Bank, around the northern and western margins of the Gulf, to the offing of Massachusetts Bay. This distribution closely parallels that of the saltest water and is explicable only on the same basis, as due to an anticlockwise eddying drift. The scarcity of tropicals over Georges Bank and in the central part of the basin, just where they would naturally be most frequent if they drifted in directly from the south, is especially suggestive.

The courses of some 1500 drift bottles put out in the western side of the Gulf since 1922, with many others launched in the eastern part and in the Bay of Fundy by the Biological Board of Canada, are again reconcilable with one another, and with the distribution of salinity and of the plankton, only on the assumption that the waters of the Gulf eddy anticlockwise (Figs. 13 and 14).

With enough river water emptying into the Gulf to raise its surface by about ½ a fathom yearly (local rainfall more than balances evaporation) and with indrafts into its eastern side, both deep and on the surface, obviously the Gulf discharges somewhere and in large volume. Salinities and the drifts of bottles locate this discharge as chiefly out of its western side, past Cape Cod and Nantucket Shoals and partly clockwise around the eastern end of Georges Bank, so joining the more widespread set that trends southwestward along the edge of the continent.

CAUSES OF THE DOMINANT CIRCULATION OF THE GULF

Three possible motive forces at once spring to mind in explanation of this dominance of the basin of the Gulf by a great anticlockwise eddy: the hydrostatic forces set in operation by regional differences in the density of the water; the winds; and, as newly suggested by Dr. A. G. Huntsman,[7] the tidal oscillations as deflected by the effect of the earth's rotation.

Within recent years the application of Bjerknes' hydrodynamic theory to ocean currents has been so simplified, especially by Ekman, Helland-Hansen, Sandström, Hesselberg and Sverdrup, and Smith, that no oceanographer need longer dread the mathematical processes necessary for dynamic study of the seas with which he is concerned. The physical laws involved are indeed of the simplest, embodied in the old adage "water runs downhill." Unfortunately, however, deduction of the movement of the water from the calculated dynamic gradients gives relative results only, not absolute. The correctness of the deduced current, relative to the bottom (which is what really concerns us), depends on the assumption that somewhere in the picture there is motionless water to start from. And this entails the second assumption that a correct choice has been made of the station or stratum assumed stationary or nearly so; neither of which assumptions is capable of mathematical proof.

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[7] A. G. Huntsman: The Importance of Tidal and Other Oscillations in Oceanic Circulation, *Trans. Royal Soc. of Canada*, Ser. 3, Vol. 17, 1923, Section V, pp. 15–20.

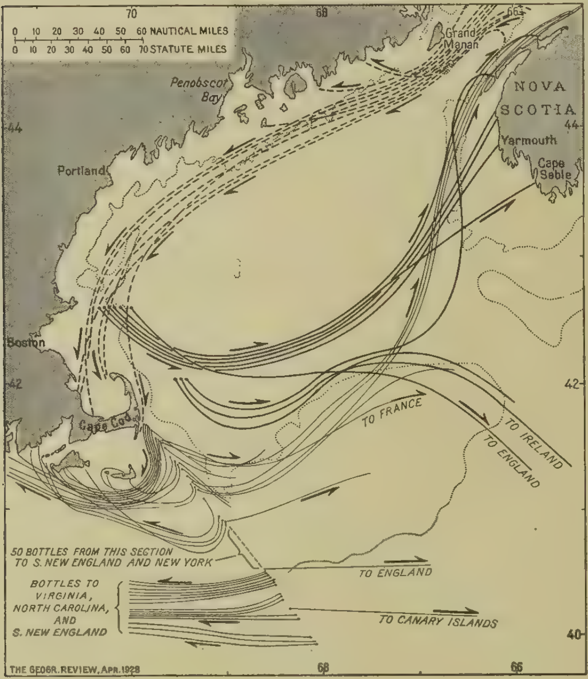
70
68
66
0 10 20 30 40 50 60 NAUTICAL MILES
0 10 20 30 40 50 60 70 STATUTE MILES
Penobscot Bay
Grand Manan
NOVA SCOTIA
44
Yarmouth
Cape Sable
Portland
Boston
42
Cape Cod
TO FRANCE
TO IRELAND
TO ENGLAND
50 BOTTLES FROM THIS SECTION TO S. NEW ENGLAND AND NEW YORK
TO ENGLAND
BOTTLES TO VIRGINIA, NORTH CAROLINA, AND S. NEW ENGLAND
TO CANARY ISLANDS
40
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FIG. 13—Assumed drifts of bottles put out in the Bay of Fundy in the summer of 1919 by the Biological Survey of Canada (broken curves, after Mavor); to the southward of Cape Cod in July, 1922 (solid curves); in the offing of northern Cape Cod and off Cape Ann in August, 1923 (solid curves).

The method of attack adopted for the Gulf of Maine has been that of the dynamic contour chart, chosen as the simplest application of Bjerknes' theorems and as on the whole the most instructive for areas where a network of observing stations allows horizontal projection of the dynamic gradients. Projections of this sort can also be constructed for any desired pressure depth below the surface—an added advantage. The procedure employed in this method, widely used of late, has recently been described in full detail by Smith[8] as applied to deep oceans. When extended to shoal seas, varying in depth from station to station, as Jacobsen and Jensen emphasize,[9] complications ensue due to the necessity for taking into account the whole mass of water between every pair of stations and not merely the depth column included at the shoaler of the two. In the present state of our knowledge, this allowance entails an empiric correction which admittedly can give only an approximation to the truth. Consequently the opportunity offered in the Gulf of Maine to correlate the prevailing dynamic state of the water with a well marked and persistent type of dominant circulation, fully demonstrated by other lines of evidence, has been most welcome. Our procedure in this case, backward (if you will) from effect to cause, reverses that of several recent studies and purposely so.

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[8] Edward H. Smith: A Practical Method for Determining Ocean Currents, *U. S. Coast Guard Bull. No. 14*, 1926.

[9] J. P. Jacobsen and A. J. C. Jensen: Examination of Hydrographical Measurements from the Research Vessels "Explorer" and "Dana" during the Summer of 1924, *Rapports et Procès-Verbaux des Réunions, Conseil Perman. Internatl. pour l'Expl. de la Mer*, Vol. 39, 1926, pp. 31–84: reference on p. 40.

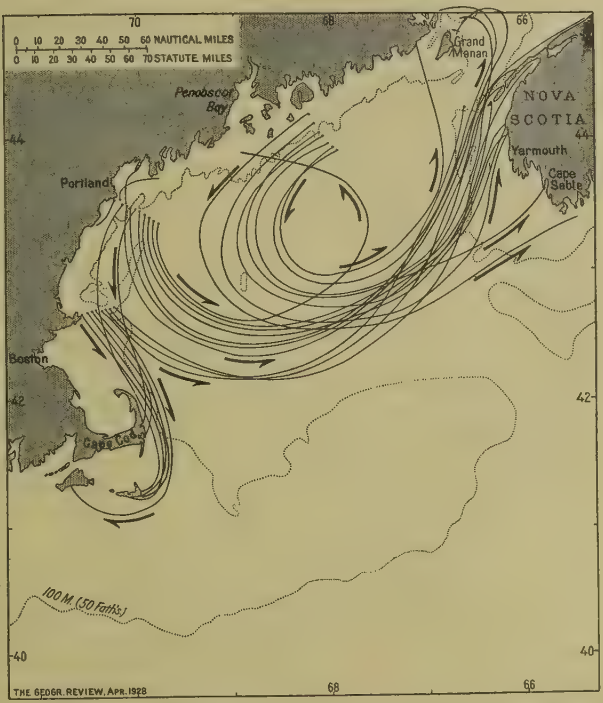

FIG. 14—Assumed drifts of bottles set out in the offing of Cape Ann in April, 1926; in the offing of Cape Elizabeth and off Mt. Desert Island in August, 1923.

For reasons too technical to discuss here, the gradients shown on a dynamic contour chart simulate the actual slope of the surface more or less closely, according to the correctness of the underlying assumptions just stated and of the empiric allowance made for differences in depth between adjacent stations.

Such a chart resembles an ordinary weather map in general appearance and is to be interpreted similarly. That is, the water tends dynamically to flow down from the parts of the picture where the surface stands highest, to the depressions where the surface is lowest. But the deflective effect of the earth's rotation—to the right in the northern hemisphere—actually brings the drift so nearly parallel to the dynamic contour lines that these last may be taken as representing the stream lines wherever the contour of the bottom allows—and this is a very important proviso—the current having the highest surface (lightest water) on its right hand in the northern hemisphere, on its left hand in the southern.

The dynamic contour charts for the surface of the Gulf of Maine have proved fundamentally similar from season to season, with the surface invariably standing highest alongshore, lowest somewhere over the basin (the precise locality varying from month to month) and outside the edge of the continent. Some such distribution was, of course, to be expected from the large amount of fresh (i. e. light) water emptying into the Gulf around its coast line, with the surface highest close to the greatest inflowing of fresh water, just as rules in the North Sea.

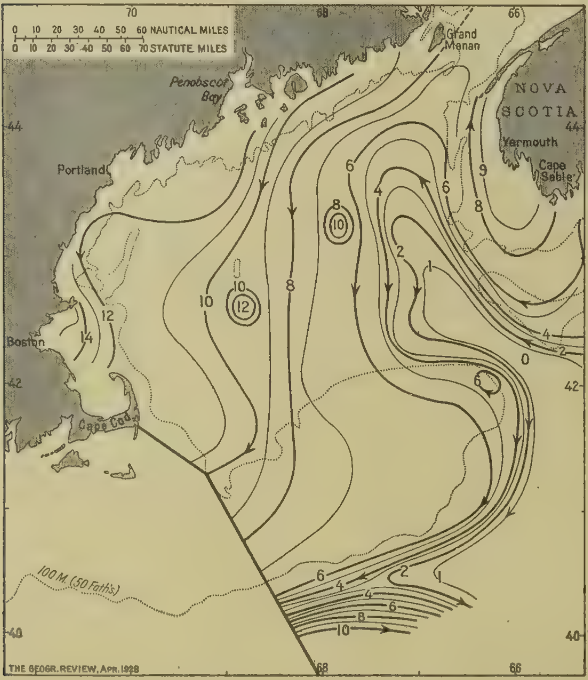

FIG. 15—Dynamic contour of the surface of the Gulf of Maine, February–March, 1920, referred to the depression in the eastern channel as base. Contours in dynamic centimeters. From p. 937, *Bull. Bur. of Fisheries*, Vol. 40, Part II.

The seasonal changes in the state of the Gulf, in summary, have been as follows in the years of record. At the end of the winter the surface is lowest over and just within the Eastern Channel, rising steeply over the banks on either hand and radially in toward the coast line (Fig. 15). By April, as the margin of the Gulf is freshened (hence lightened) by the river freshets, the dynamic slope of the surface is steepened along the northern and western slopes, while the "low" spreads to include the whole eastern side of the basin. The gradient is still steeper in May, when the surface is lowest in the western side of the basin. In summer, as the land water is mixed into the Gulf of Maine and the regional differences that have been already discussed develop in the warming of the water, the surface slope flattens next the shore, while two depressions develop offshore, the one in the offing of Mt. Desert, the other over the Eastern Channel, with a steep rise along the eastern face of Georges Bank (Fig. 16).

During the autumn and winter progressive equalization of temperature and of salinity in the shoaler strata of the Gulf again transform the dynamic contour of the Gulf to the more simple state characteristic of the early spring.

These contour charts make it evident that, on the whole, hydrostatics, as confined by the contour of the bottom, do actually tend to produce an anticlockwise movement of the surface water around the basin of the Gulf of the type recorded by the more direct lines of evidence just summarized. There is, in fact, no movement called for by the dynamic contours that is not also indicated by bottle drifts, by salinity, by temperature, or by the plankton.

One other aspect of these dynamic charts demands space, because it is explanatory of important phenomena otherwise puzzling: namely the contours around the eastern and southern slopes of Georges Bank.

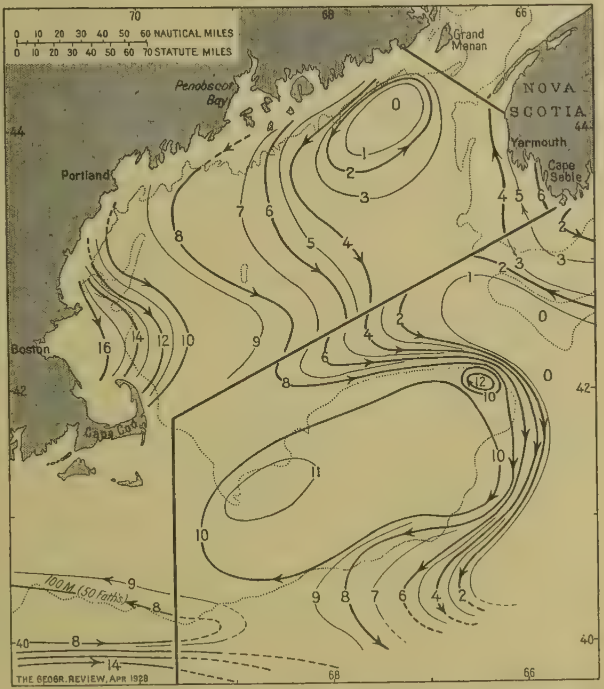

Fig. 16—Dynamic contour of the surface of the Gulf of Maine, July (north and west of the heavy dividing line) and August (south and west of the division), 1914. Contours for every dynamic centimeter from p. 956, *Bull. Bur. of Fisheries,* Vol. 40, Part II.

One of the most interesting facts in the Gulf of Maine complex is that the Gulf Stream, drifting close past its offshore slope, should so little affect the waters within the Gulf. On the opposite side of the North Atlantic—in the Bay of Biscay for example, and northward over the Norwegian Sea—northerly encroachments by the warm oceanic water are annual summer events of great importance in biologic economy. Topographically, at least, the Gulf of Maine lies equally wide open to overflows from the Gulf Stream; and the strong southerly winds, frequent in summer, would favor such. However, the boreal character of the fish fauna and of the bottom dwellers generally, not only within the Gulf but over its outer rim even out nearly to the edge of the continent, proves that if such overflows do occur, they must be confined to a very superficial stratum. And fortunately so; for existence on Georges and Browns Banks and on Nantucket Shoals would be impossible for cod, haddock, halibut, and other boreal fish were they sporadically subject to the sudden and extreme warming of the water which any voluminous flooding by the Gulf Stream would cause.

Actually no such event has come under our observation in any year or season, the nearest approach being early in September of the past summer, when Mr. C. Iselin found the bottom water 12° in temperature, the surface 21°, along the 100-meter contour on the offshore slope of Georges Bank, contrasting with 14–18° on the fishing grounds on the Bank. Later in the month "*Albatross II*" reported large amounts of gulfweed (*Sargassum*), with tropical fishes, scattered over the eastern part of the Bank. But, as the temperature there (13°–15° at the surface, about 9° at 40 meters, and about 8° at 70 meters) was then no higher than the expectation for the season, this tropic flotsam had either involved only the surface skim or it may actually have been drifting south and west at the time from some overflow far to the eastward.

The invisible barrier which shuts out the Gulf Stream from the Gulf of Maine is suggested on the dynamic charts for the warm season (Fig. 16) as well as the cold (Fig. 15). Thus the latter shows a well marked trough-like depression of the surface, paralleling the slope, with the surface notably higher over Georges Bank on the one hand and further out at sea on the other—a trough, in fact, of just the sort that has repeatedly been demonstrated in the corresponding location off the Grand Banks. Oceanographers are, indeed, learning to expect some such phenomenon along the line of contact between banks and ocean waters, where the mixture of these two constituents results in specific gravities higher than that of either. Wherever such a state prevails, as in the picture in question (Fig. 15) with dynamic slopes so steep, any transgression of the water across the trough in either direction is made impossible by the development of an easterly movement along its outer edge, and of a westerly movement along its inner edge, as the rotation of the earth directs to the right (and parallel with the contour lines) the draft of surface water that gravity tends to set in motion inward toward the trough from both sides. That the inner edge of the Gulf Stream thus receives easterly propulsion from hydrostatic forces acting locally, i. e. is strictly a gradient current at least at times and is by these same forces barred from the Gulf of Maine, is not the least interesting result of our work. The summer chart (Fig. 16) suggests this as applying also in the warm season, though here the picture is not so clear. Mr. C. Iselin is now engaged in a detailed study of this whole question, as it affects the Gulf Stream off the northeast coast of North America.

If this explanation be correct, the local hydrostatic forces are also the key to another riddle, namely the prevailing tendency for warm oceanic water to wash the bottom along the continental slope, at the 100–200 meter level, as the well known "warm band," as far east as longitude 67°–68°, the precise boundary varying from season to season, but never, so far as known, to reach the Nova Scotian slope. In other words this may explain why the tilefish zone, with its equable bottom climate of 8°–12° the year round, is sharply bounded on the east.

To explain the temporary obliterations of the warm zone that are known to occur at long intervals with widespread mortality—witness the destruction of the tilefish in 1884—it is no longer needful to assume some overwhelming flood of arctic water from the north. A more likely explanation, and a simpler one, is that such events reflect some offshore shift in the location of the axis of the dynamic depression, allowing the cool discharges from the Gulf of Maine and the Banks water generally, in their drift toward the west, to spread farther out over the slope than usual.

Finally, the existence of such a dynamic trough along the zone of contact between coast and ocean waters provides propulsive power for the indraft into the bottom of the Gulf of Maine by which its estuarine character is maintained. The offshore origin of this inflowing bottom water is obvious. As obviously, however, it is not a direct indraft from the mid-depths of the ocean basin, being too little saline. Temperature (close to 8°) and salinity (34–35 per mille) as it creeps inward along the trough of the Eastern Channel between Georges and Browns Banks identify it as drawing at a corresponding depth from the cool wedge which intervenes between the edge of the continent and the inner edge of the Gulf Stream off the mouth of the Eastern Channel—the "cold wall" of the early oceanographers.

The origin of this comparatively cool water mass has been the subject of much speculation. An arctic source we have dismissed: certainly the "cold wall" off the deep channel of the Gulf of Maine and off Nova Scotia is not the direct and unadulterated southerly extension of any arctic current. Upwellings from the Atlantic abyss, did such events occur with frequency or regularity, would be another possible source for water of high salinity and of moderately low temperature, not only along the continental slope but for the basins on the American continental shelf as well. And upwellings of this sort have, in fact, been invoked in explanation; notably by Pettersson. Fortunately for our purpose the effect that any general updraft of this sort would exert on the physical character of the coastal water would be made as unmistakable by high surface salinity as it would in summer by low temperature, the neighboring abyss being about 34.9 per mille in salinity and not far from 4° in temperature. A vertical continuity, in temperature and in salinity, might also be expected between any updraft that might approach the surface and its deep-lying source. Actually, however, our first cruise, in the summer of 1912, proved that at least the inner parts of the Gulf of Maine receive little if anything from this abyssal source, its coldest stratum (4°–5°) being much too fresh (33 per mille)—a conclusion subsequently corroborated for other times of the year. The profiles since run across the edge of the continent have shown the precise combination of temperature and salinity characteristic of the cool water abreast the Gulf to be incompatible with an abyssal source, as being considerably warmer (6°–7°) than the oceanic deeps (600 meters and deeper) where the salinity is so low; correspondingly less saline than the corresponding temperature zone offshore.

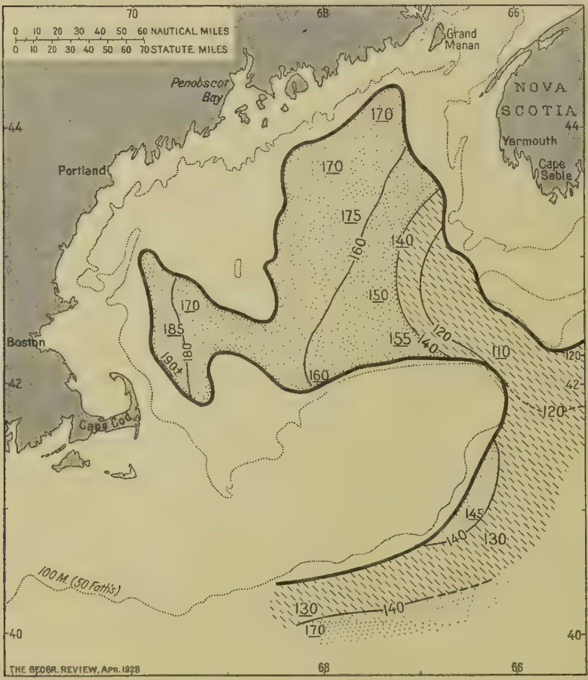

FIG. 17—Depth, below the surface of the stratum of 1.0275 specific gravity, at the temperature *in situ*, and corrected for compression, February–March, 1920.

Not only is this the rule generally along the seaward slope of the offshore banks, but even in the trough of the Eastern Channel, i. e. in the only deep entrance into the Gulf of Maine. In most cases, in fact, the coldest waters on the shelf have been separated from the equally low temperatures of the abyss by a somewhat warmer zone washing the bottom along the slope at intermediate depths (Fig. 2). Obviously, such a discontinuity in temperature argues against any prevailing movement of the water upward over the upper part of the slope. This conclusion does not mean that abyssal water may not well up over the deeper part of the continental slope. On the contrary, considerable evidence has accumulated to the effect that some such process is widespread below the 500–1000-meter level. But data so far gathered locate the upper limit of this updraft at a depth of at least 300 meters below the surface.

Actually the temperature and salinity of the sector of the "cold wall" that fronts the Eastern Channel mark it as the simple product of the mixture ever taking place between the water of the Banks on the one hand, and that of the ocean basin on the other along the zone of their conflict; the one low, the other high in salinity and in temperature. "Slope water" is then an appropriate name for it. It is because the most saline bottom water of the Gulf has this "slope" origin, and is not oceanic, that members of the bathypelagic plankton of the Atlantic basin occur only as the rarest of stragglers within the Gulf: the whole category of the black fish—red prawn community, for example, and the deeply pigmented medusae of similar biologic status. The high specific gravity of this "slope water" is responsible for the dynamic trough just described as fronting the Gulf of Maine. The profiles that have been run out from the outer coast of Nova Scotia have shown similar phenomena at about the same location relative to the edge of the continent.

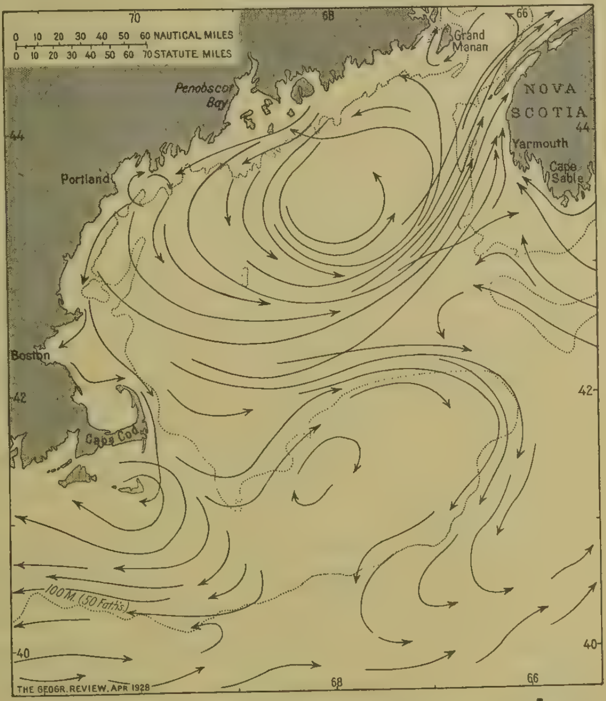

FIG. 18—General outline of the dominant circulation of the surface waters of the Gulf of Maine, in July and August. From p. 973, *Bull. Bur. of Fisheries*, Vol. 40, Part II.

Slope water is thus carried westward along the edge of the Nova Scotian shelf as a gradient current, just as it is along the southeastern face of Georges Bank (Figs. 15, 16). So long as this state persists, the submarine bight off the mouth of the Eastern Channel is kept supplied with water from the eastward, from the seaward slopes of Browns and La Have Banks; probably never from the westward. Forced against Browns Bank by the deflective force of the earth's rotation, the channel offers an open route for the slope water into the bottom of the basin of the Gulf of Maine, a route followed in pulses the secular succession of which is not yet clear. The surfaces of equal density dip steeply from the channel inward across the basin (Fig. 17); only by a constant renewal of water of high specific gravity at the offshore side could this unstable state be maintained against the constant tendency of the force of gravity to reduce the surfaces of equal pressure to the horizontal.

Once it has penetrated the bottom of the Gulf, the slope water is consumed in the inner part of the basin, where vertical stirrings mix it with the overlying strata. Thus freshened by incorporation with much lower salinities, it is again discharged out of the Gulf near the surface, as a constituent of the ordinary Banks water; and when it reaches the edge of the continent in this way it again takes part, as the inshore constituent, in the formation of new slope water farther west.

The anticlockwise character of the Gulf of Maine eddy cannot, however, be explained as a gradient drift pure and simple because, as Dr. Huntsman has recently pointed out, the effect of the earth's rotation in deflecting the horizontal oscillations of the tides tends to produce this same anticlockwise movement within basins in the northern hemisphere, clockwise around banks. This hypothesis is still to be subjected to the quantitative analysis for any one particular region, which alone can show how closely the actual progressive movement of the water agrees with the theoretic expectation in its velocity or to what extent it is kept in motion in this way. Meantime, I can only point out that there is good ground for concluding that in basins enclosed sufficiently for either the coast line or for a submerged rim to confine the oscillatory tidal path of the water as deflected to the right (in the northern hemisphere), a progressive movement will result, inward on the one side and outward on the other, of just the type actually exemplified by the Gulf of Maine eddy. The extensive drift-bottle experiments which have been carried out during the past five years along the northeastern American seaboard have in fact shown the water tending to eddy similarly, anticlockwise, in other basins, e. g. the "Scotian eddy," and to circle banks and islands clockwise, just as this theory of deflected tidal oscillations demands.

Finally, the wind must be taken into account, as it affects the circulation of the waters of the Gulf of Maine. This is a complex problem, difficult of solution because of the impossibility of deriving, from any theoretic calculation, the track to which the contour of shore line and bottom will actually divert the current which any given wind would set in motion in the "free ocean"of the oceanographers.

The best indications of this resultant track are the currents which have actually been found to follow different winds at various lightships. Briefly, these show that, when not actually opposed by the coast line, wind currents near the land in our hemisphere are diverted by earth rotation on the average 20° to 25° to the right of the wind. Thus the prevailing south-southwest winds of summer help maintain the drift out from the western shore of the Gulf of Maine and eastward across the southern side of its basin toward Nova Scotia—

i. e. the southern side of the Gulf of Maine eddy. The wind is thus partly responsible for the accumulation of warm surface water in the offing of Massachusetts Bay in July and August. Any such wind drift across the southern side of the Gulf, striking the coast of Nova Scotia, naturally tends to strengthen the northerly movement across the wind-current track, otherwise kept in motion in that side of the Gulf. But the return movement westward around the northern shore of the Gulf is contrary to the wind.

Winds prevailing from the sector between southwest and north in winter and early spring tend, similarly, to strengthen the southerly drift along the western shores of the Gulf that results from the inpouring of fresh water, with the consequent elevation of the surface. And northwest winds favor the discharge out of the western side of the Gulf. But, like the eastern side of the Gulf of Maine eddy, this latter is across the wind-drift track during the summer months; and the westerly movement of the slope water along the edge of the continent is directly opposed by the prevailing winds. Furthermore, though prevailing from the quarters just stated, the winds are variable over the Gulf of Maine at all seasons, seldom blowing in any one constant direction for more than a few days. On the whole, therefore, we may conclude that the general circulatory system that dominates the superficial stratum of the Gulf is not kept in motion by the winds, though the latter favor it more often than they oppose. And, if our theoretic concept of wind-driven currents be at all just, it is certain that the indraft of slope water into the bottom of the Gulf is entirely independent of the wind.

The dominant circulatory movements of the Gulf of Maine may thus be described as composed of three major systems. First, there is the anticlockwise eddying of the upper stratum around the basin of the Gulf, kept in motion by the local hydrostatic forces, plus the progressive motion resulting from the deflective effect of the earth's rotation as this acts on the tidal oscillations. Second, we have to do with the pumping of slope water inward along the floor of the Gulf from offshore, which is effected again hydrostatically by the balance maintained between the maintenance of a supply of such water off the Eastern Channel and its consumption in the inner parts of the Gulf. Third, there is the constant discharge from the Gulf near the surface, balancing this indraft and the indrafts at the surface from the offing of Cape Sable; balancing, too, the contribution of river water that the Gulf annually receives. To all of this the Gulf of St. Lawrence offers so close a parallel that this scheme is clearly typical for basins of this general topographic type, if they bear a similar relationship in temperature to the oceans they front.

The features of the Gulf so far mentioned—temperature, salinity, and dominant circulation in its broad outlines (not yet in detail)—

are now known, broadly speaking. With their elucidation the first objective of our physical exploration of its waters has been attained. The final goal, the explanation of the natural economy of its inhabitants in terms of their physical and chemical environment, lies, however, far ahead. This is to be sought not so much by the generalized surveys of a large area carried out so far as by more detailed study of the physical, and especially of the chemical, changes in the water from season to season at standard locations. How fertile such studies may be expected to prove is made evident by the very striking parallelisms between the abundance of vegetable plankton and the varying concentration in the sea water of such ultimate foodstuffs as phosphorus, nitrogen, and silica, such as have recently been demonstrated by the British naturalists at Plymouth[10] and by Raben at Kiel.[11]

Up to date, our only contribution of this sort, for the waters of the Gulf of Maine, has been a series of periodic determinations of the silica content of the water off Gloucester during the years 1920 and 1921, which showed a decided maximum in February–March (2.6–3 parts per million) followed by a notable impoverishment (to .4 part per million) in May, with a secondary maximum (1.4 parts per million) at the end of June, followed in turn by a second depletion in late summer and early August.

As described elsewhere[12] this corresponds in general with the usual seasonal schedule of diatoms in that general region, the active flowering of spring and the secondary flowering of September following the maxima for silica so closely that a causal connection is at least probable though not demonstrated.

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[10] W. R. G. Atkins: The Phosphate Content of Fresh and Salt Waters in Its Relationship to the Growth of the Algal Plankton, *Journ. Marine Biol. Assn.*, Vol. 13, pp. 119–150, Plymouth, Engl., 1923–25; *idem:* Seasonal Changes in the Phosphate Content of Sea Water in Relation to the Growth of the Algal Plankton during 1923 and 1924, *ibid.*, pp. 700–720.

[11] E. Raben: Quantitative Bestimmung der im Meerwasser gelösten Kieselsäure, *Wiss. Meeresuntersuchungen, Komm. zur wiss. Untersuchung der deutschen Meere*, Vol. 8 (N. S.), pp. 99–101, pp. 279–287; Vol. 11, pp. 303–319; Vol. 16, pp. 207–229, Kiel and Leipzig, 1905, 1910, 1914.

[12] H. B. Bigelow: Plankton of the Offshore Waters of the Gulf of Maine, *Bull. U. S. Bur. of Fisheries*, Vol. 40, Part II, 1926, p. 476.

WHITE COAL IN ITALIAN INDUSTRY

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University of Illinois

ITALY, until recent years, has been almost exclusively a nation of farmers, and even today over one-half of the population is directly dependent for its livelihood upon the exploitation of the soil. The past third of a century, however, has witnessed a remarkable industrial development. The world war, with its restriction upon imports and at the same time with its enormous demands for manufactures, greatly accelerated a movement which is making of northern Italy an industrial region of no insignificant proportions.

For the explanation of this rapid growth, one need not seek far. Considering its resources, Italy is one of the most densely populated countries of Europe. Ribbed with youthful mountains and having considerable areas deficient in rainfall, to support its population of over forty millions by agriculture alone is out of the question. Furthermore, population is increasing rapidly with an annual excess of births over deaths of some 400,000. Two solutions for the disposition of the surplus man power present themselves, emigration and industrialization. The former has long served as the major safety valve of overpopulation. In the absence of an extensive colonial empire there has been a huge annual exodus to the countries of the New World and to adjacent countries in the Old World. From 1910 to 1913 the average emigration was about 700,000 annually. The war and restrictive legislation, particularly in the United States—the most favored destination—reduced the numbers so that in the six years from 1921 to 1926 they have averaged slightly under 300,000. This situation goes far in helping to explain Italy's efforts in recent years to enlarge her colonial empire, to intensify her agriculture, and to expand her industrial activities.

OBSTACLES TO INDUSTRIALIZATION

The unique character of Italian industrialism lies in the formidable nature of the obstacles with which it is confronted. Italy has but scant supplies of the basic raw materials and still less of the fuels—two requirements the possession of at least one of which has been considered fundamental for a modern industrial nation. In fact, Italy is the least self-contained of all the great industrial nations of the world. Her industrial structure is supported instead upon the two pillars of an abundant supply of comparatively cheap but efficient labor[1] and an unusually rich endowment of water power.

Italy's reserves of coal, lignite, and peat are estimated to total only 340 million tons; and of this amount almost 90 per cent is lignite.[2] Practically all of the coal mined comes from Istria in the

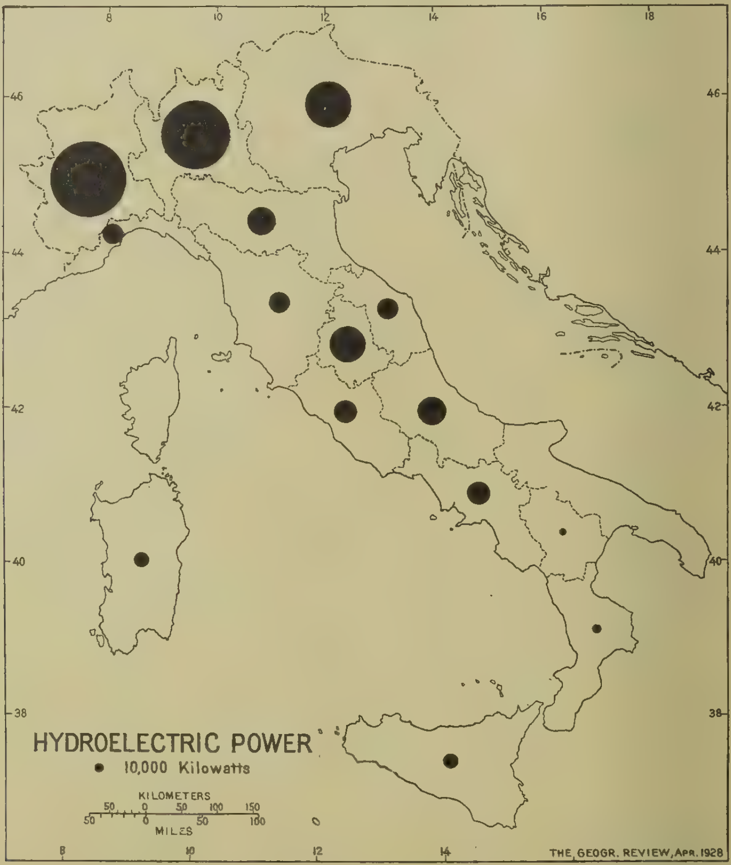

FIG. 1—Installed hydro-electric power of all plants having a capacity of 300 kilowatts or over, December, 1925. Based upon data by Ministero dei Lavori Pubblici, Servizio Idrographico, *Trans. World Power Conference, Sectional Meeting, Basle, 1926*, Vol. 1, p. 360. Scale of map 1: 10,500,000.

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[1] Skilled mechanics in Italy now receive a wage equivalent of not more than $1.25 a day; common labor, less than $1.00 (H. C. MacLean in *U. S. Dept. of Commerce, Trade Information Bull. No. 337*, Washington, 1927, p. 12).

[2] G. De Marchi: General Report on the Power Resources of Italy, Developed and Undeveloped (Historical, Economic, Statistical), *Trans. First World Power Conference, London, 1924*, Vol. 1, pp. 944–962. See also J. R. Bradley: Coal in Europe, *U. S. Dept. of Commerce Trade Information Bull. No. 489*, Washington, 1927. Research on her mineral resources has been actively prosecuted by Italy in the last few years and a more optimistic opinion has been expressed by Sig. Belluzzo, Minister of National Economy. See Report on the Commercial, Industrial and Economic Situation in Italy, 1927, Dept. of Overseas Trade, London, 1927. See also A. Baldacci: L'industrie minière et sidérurgique en Italie, *Rev. Internationale*, Vol. 19, 1927, pp. 59–80.

territory newly acquired from Austria, a section whose reserves are estimated at only 13 million tons. Unfortunately it is high in sulphur content and unsuited for many special purposes, including the making of metallurgical coke.

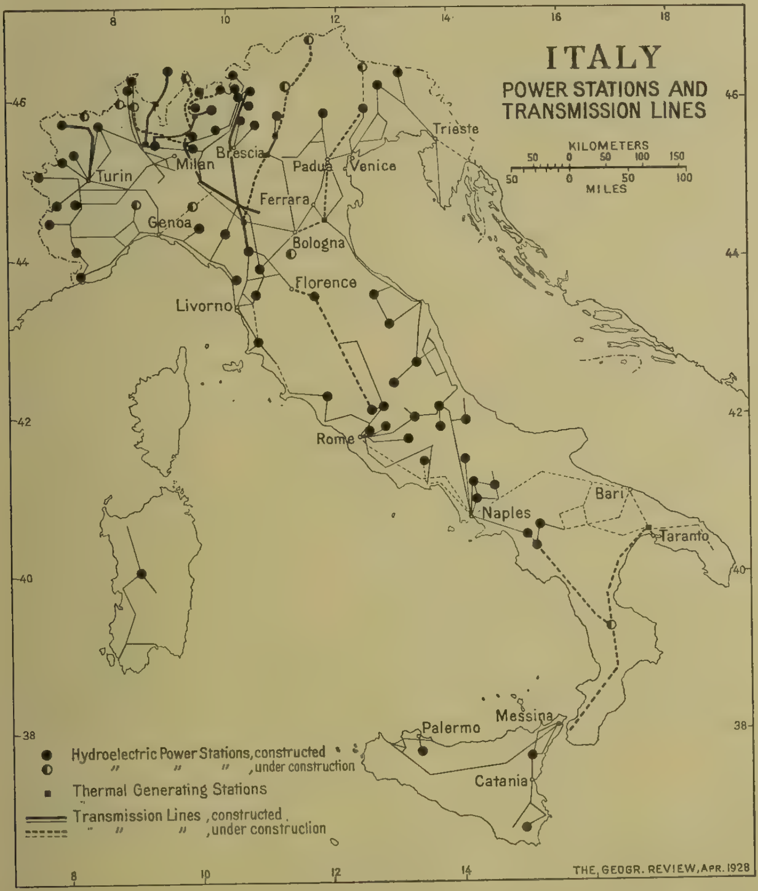
ITALY
POWER STATIONS AND TRANSMISSION LINES
KILOMETERS
50 0 50 100 150
50 0 50 100
MILES
Turin
Milan
Brescia
Padua
Venice
Trieste
Ferrara
Genoa
Bologna
Florence
Livorno
Rome
Bari
Naples
Taranto
Palermo
Messina
Catania
● Hydroelectric Power Stations, constructed
◐ " " " , under construction
■ Thermal Generating Stations
Transmission Lines, constructed
" " " , under construction
8
10
12
14
16
18
46
44
42
40
38
THE GEOGR. REVIEW, APR. 1928

FIG. 2—Diagram showing approximate network of high tension transmission lines linking up the various power stations in Italy in operation and under construction. Italy operated over 45,000 kilometers of high tension transmission lines in 1925. Adapted from E. Vismara, *Trans. First World Power Conference, London, 1924*, Vol. I, pp. 981–1002. Scale of map 1:10,500,000.

The lignite is likewise of poor quality, having a calorific value only one-fifth to one-third of that of soft coal. The location of the deposits also is unfavorable, most of them being in the non-industrial central provinces. Since the cost of the lignite at the mines is only slightly less than that of imported coal at Italian ports, its use is limited to the immediate vicinity of the producing area. The establishment of thermo-electric stations at the mines, begun in 1907, seems to be the practical solution of the problem of their utilization.

By 1924 these plants, already operating or under construction, had a capacity of 70,000 kilowatts. It has been estimated that the total reserves could supply from 150,000 to 300,000 kilowatts for from 50 to 100 years.[3]

During the war the production of coal of all grades was forced up to over two million tons (1918). However, increased freight rates and renewed imports, especially German reparations coal,[4] have caused all the coal mines except those in Istria and the most favorably located lignite workings in Tuscany to close down. In the case of oil the outlook is even less promising, the production of 5000 metric tons annually being about half of one per cent of the nation's consumption.

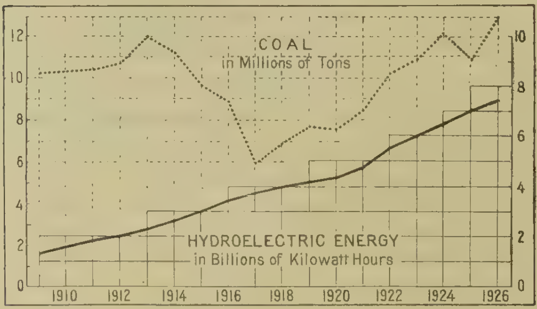

FIG. 3—Consumption of electrical energy in Italy and consumption of coal during the same period. After G. Mortara: Prospettive Economiche, Vol. 7, 1927, p. 308.

WATER POWER DEVELOPMENT

The "silver lining" in the Italian power situation consists in the country's possession of magnificent water power resources; and her record of hydro-electric exploitation, especially since the war, has been a notable one. In the decade following 1914 the capacity of the installed plants was doubled and by the end of 1925 had reached 2.38 million kilowatts, the actual power produced, meantime, having trebled.[5]

As may be seen from Figure 3, the phenomenal development of water power has failed, however, to diminish the coal consumption. Had the power demands of 1925 remained at the 1913 level, the added hydro-electric development and increased oil imports would have reduced the coal purchases by one-half. It appears, then, that the increased exploitation of water power has but kept pace with the industrial expansion, and the coal import requirement of some 11 or 12 million tons must be expected to continue if not actually to increase. The quantity of fuel oil used is so small as to be a negligible factor in the situation.

The rapidity with which the industrial activities of Italy have been expanded has still another factor in its explanation—the familiarity of the Italian people with the science of hydraulics. Climate and topography—especially in peninsular Italy—coupled with recklessness in deforestation, forced the Italians to an early study of stream control. For centuries the problems of erosion, irrigation, drainage, and city water supply have been of intimate concern to the masses of the population. Likewise the scarcity of wood and the abundance of stone served to develop the art of masonry so that the Italians today are noted for their proficiency in dam construction. It is not surprising, then, that Italy has long been in the vanguard of electrical progress. Nor was it an accident that that country was the first to transmit current in large amounts over long distances—the Tivoli-Rome line having been successfully operated some 35 years ago.[6] Likewise the Florence-Fiesole electric railway was the first to provide such service regularly in Europe.

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[3] *Commerce Repts.*, May 25, 1925, p. 459.

[4] The arrangement by which Italy was to receive reparation coal from Germany was originally regarded as a great boon. However, the agreement calls for delivery f. o. b. mines, and the one-thousand-mile rail haul over the Alps makes it more expensive than imported English coal (A. L. P. Dennis: The Romance of World Trade, New York, 1926).

[5] Ministero dei Lavori Pubblici, Servizio Idrografico, Roma: La produzione di energia elettrica in Italia nel 1925, *Trans. World Power Conference, Sectional Meeting, Basle, 1926*, Vol. 1, pp. 341–358.

NORTHERN ITALY

Italy's water turbines are about as unequally distributed as are her agricultural activities. The lion's share of both is possessed by the north, for both are the offspring of the Alps. The great fertile plains of the Po are built of alluvium contributed in the main by the Alpine slopes which thus reclaim what was formerly an arm of the Adriatic. The same streams which changed a waste of waters into one of Europe's garden spots are today being harnessed to the wheels of industry located on these same plains. While the plain occupies less than three-twentieths of the area of the kingdom it has three-eighths of the population[7] and in the city of Milan has the industrial metropolis of the country.

Obviously the physical setting of northern Italy is peculiarly well suited to the development of hydro-electric power.[8] The height of the Alps is responsible for a heavy precipitation and for sufficiently low temperatures to maintain extensive snowfields and glaciers and at the same time to furnish a high head for the streams. Many moraine-dammed valleys constitute huge natural lake reservoirs which serve to equalize the stream flow.

The rainfall régime (see Fig. 4), by seasons shows two slight maxima, spring and autumn, and one moderate minimum in winter.[9] However, the seasonal difference is much more marked in the stream discharge. The maximum run-off coincides with the time of greatest melting of snow and ice, i. e. in summer; the winter flow being less than one-third of that in summer. The Adige with its impermeable basin and its absence of large lakes exhibits a somewhat unusual régime, with a marked summer maximum of precipitation and run-off.

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[6] Emirico Vismara: Hydro-Electric Plants in Italy and Their Contribution to National Economy, *Trans. First World Power Conference, London, 1924*, Vol. 1, pp. 981–1002.

[7] Luigi Giannitrapani: La popolazione e i centri abitati della pianura padano-veneta secondo gli ultimi censimenti, *L'Universo*, Vol. 4, 1923, pp. 9–23.

[8] Compare Raoul Blanchard: Geographical Conditions of Water Power Development, *Geogr. Rev.*, Vol. 14, 1924, pp. 88–100.

[9] G. De Marchi: The Italian Organisation for Survey of Rivers: Their Standard Levels and Exploitation, *Trans. First World Power Conference, London, 1924*, Vol. 1, pp. 963–980.

The actual exploitation of water power in different parts of Alpine Italy varies with the local features.[10] Thus Piedmont, in the extreme west, has steep slopes and relatively inaccessible valleys so that the establishment of industrial plants there has been slow.[11] Even where rich iron ores were to be found, as at Cogne, they remained untouched until war time demanded forced action. One of the most interesting developments in this province is the Lake Moncenisio plant. This reservoir impounds over one billion cubic feet of water, and the fall is utilized at two sites, one with a head of five hundred feet, the other thirty-two hundred feet, the highest head plant in Europe. At present Piedmont leads in the number of installations and the power developed.[12]

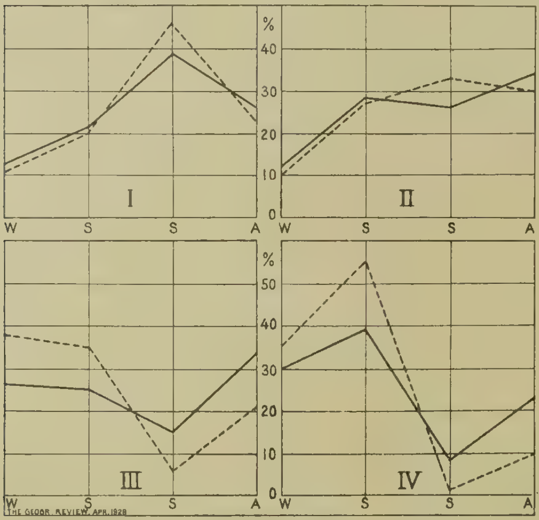

FIG. 4—Seasonal distribution of precipitation (solid line) and run-off (broken line) of typical drainage basins expressed as a percentage of the total annual amount. I, Adige; II, Maggiore; III, Arno; IV, Tirso. Based upon data by G. DeMarchi: *Trans. First World Power Conference, London, 1924*, Vol. 1, p. 968.

Lombardy has a pre-Alpine zone with moderate slopes and a series of finger lakes which serve as great reservoirs so that water power development here is easy. Naturally this has been one of the earliest of the developed regions, textile manufacturing being very important. Recently this section has seen also a remarkable growth in the metallurgical and electro-chemical industries.

Venetia, in the east, its torrential streams uncontrolled by lakes or glaciers, offers the poorest opportunities for hydro-electric development in all the Alpine provinces. The installations are few but are large in size; and, since the province is primarily agricultural, the current is carried long distances to market, chiefly to Venice.

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[10] G. Anfossi: L'industrie de la houille blanche en Italie, *Ann. de Géogr.*, Vol. 27, 1918, pp. 196–226 and 388–389.

[11] The southeastern part of the province falls in the Apennine region where conditions are far less favorable for hydro-electric development. See Adele Sandri: La distribuzione delle forze idroelettriche nel Piemonte, *Riv. Geogr. Italiana*, Vol. 30, 1923, pp. 134–149.

[12] Ministero dei Lavori Pubblici, Servizio Idrografico, Roma: Censimento delle grandi utilizzazioni idrauliche per forza-motrice esistenti in Italia, *Trans. World Power Conference, Sectional Meeting, Basle, 1926*, Vol. 1, pp. 359–370.

In the newly acquired Trentino, hydraulic development has not yet reached an advanced stage; but projects now under construction promise to transform a hitherto poor mountain region into a moderately prosperous industrial area. Estimates assign to the region a reserve of about 750,000 kilowatts.

The great preponderance of the north in water development is shown in Figure 1. That section accounted for almost three-fourths (72.5 per cent) of the power of plants operating or under construction by the close of 1925. Central Italy had but 16.3 per cent, while southern Italy and the islands had only 11.2 per cent.

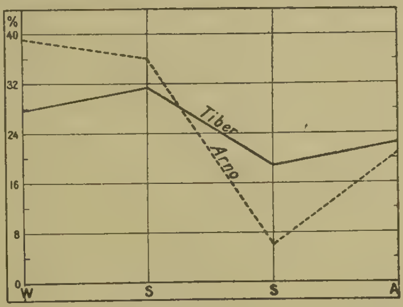

FIG. 5—Discharge by seasons of the Tiber and Arno. The rainfall régime of the two is practically the same. The Arno basin is impermeable, that of the Tiber has one-third of its surface permeable limestone.

CENTRAL ITALY

The northern and central Apennines are less favorable for water power exploitation than even the poorest of the Alpine provinces. The mountains are lower, there is less snow, and there is a total absence of large lakes or glaciers. Furthermore, the climatic conditions are unfavorable—the more so the farther south one goes. Rainfall is smaller, evaporation about twice as great, and seasonable distribution of precipitation less fortunate. Even in the northern Apennines the summer minimum is marked (see Fig. 4, III). River discharge is still less uniform than rainfall. Liguria has an extremely heavy rainfall and perhaps the largest per capita consumption of electric current of the Italian provinces, yet precipitation is most disconcerting in its lack of regularity. At Genoa, for instance, the total rainfall for 1921 was 1763 millimeters; the following year, 522 millimeters; in 1925, 759 millimeters; the following year, 2017 millimeters. For the most part the rivers are torrential and short, many becoming dry beds in midsummer. As a consequence the hydroelectric plants are smaller than in the Alpine region where large streams and fairly even volume justify plants of tens of thousands of horse power each. About one half of all the plants use falls with a head of from 20 to 200 meters, 40 per cent use high falls, 1000 to 1500 meters, and only 10 per cent utilize heads of less than 20 meters.

Again, as in the north, there are marked variations in the river basins. Thus in Figure 5 is shown the effect of differences in the geological character of the watershed. The Tiber and the Arno have essentially the same rainfall régime, but about one-third of the basin of the former is permeable, while the latter is wholly impermeable. As a result the discharge curve for the Arno closely resembles that of the rainfall, while in the case of the Tiber the stream maintains a much more uniform flow.

SOUTHERN ITALY AND ISLANDS

Southern Italy has remained largely oblivious to the feverish industrial development of the north. It is essentially agricultural with but few industries requiring power. The small annual precipitation and its more pronounced seasonal distribution provide few streams of value for power development. The rainfall and run-off régime of the rivers are much like those of Sicily and Sardinia (see Fig. 3, IV).

The average annual consumption of electricity in Italy was calculated for 1924–1925 to be 176 kilowatt hours per capita. The maximum for Italy was in Umbria, which used 784 kilowatt hours per capita, the minimum in Apulia, Basilicata, and Calabria, the "heel and toe" of Italy, Basilicata only using 4 kilowatt hours per inhabitant.[13] In the use of electricity for light Calabria in 1923–1924 reported a consumption of 2.85 kilowatt hours per capita; Piedmont, 26.7; almost ten times as much, while Italy as a whole averaged 13.7. In electrification, as in the modernization of their agriculture, the provinces of southern Italy and the islands have lagged behind those of the center and north.

However, there are indications of a change, for there is under construction in the Sila Mountains in the "toe" of Italy one of the largest hydro-electric enterprises of recent years. Here artificial reservoirs will provide a total head of over 3000 feet capable of developing some 120,000 kilowatts. The problem of markets is yet to be solved. Calabria, it is estimated, could use 15,000 kilowatts, Apulia 40,000 more; some may go north to Campania, and a transmission line is under construction to carry current across to Sicily. To agriculture in Sicily drought is the big obstacle. If, through local development and imported power, irrigation can be brought to some of her fertile plains, now worthless for lack of water, it will benefit a most needy region. To this end projects are now under construction near Palermo and also near Etna. The Hone reservoir, producing 20 million kilowatt hours and irrigating a large area besides, involved the diversion of the Hone River, whose original outlet was on the southern coast, to the Tyrrhenian side of the island.

In Sardinia conditions are still less favorable. In the whole of that island there is not a single permanent stream. River channels contain more or less water for about four months of the year, with the volume fluctuating widely from day to day; for the remaining eight months the courses are practically dry. The Tirso basin in the middle west, whose rainfall and run-off distribution are shown in Figure 4, has been known to receive one-half of its annual inflow within a period of 15 to 20 days. As indicated, the rainfall is typically Mediterranean, 70 per cent coming in the winter and spring, while 90 per cent of the run-off occurs in the same period. Uncontrolled, such rivers are more of a liability than an asset either for irrigation or power. Fortunately the topography is favorable for dam construction, and a huge project for the control of the Tirso has just been completed.[14] The works include a reservoir holding 460 million cubic meters, capable of generating 50 million kilowatt hours of current as well as irrigating over 74,000 acres of agricultural land. Incidentally the reservoir also eliminates the necessity of maintaining costly dikes built along the lower course as a protection against flood.

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[13] Giorgio Mortara: Prospettive economiche, Vol. 7, 1927, p. 305.

IRONING OUT THE ENERGY CURVE

Of the various handicaps to hydro-electric development in Italy, lack of uniformity in the flow of the rivers is apparently one of the most serious. This difficulty is, as we have seen, greatest in the south. Three methods of ironing out the inequalities in the discharge curves are commonly used. They are: (1) artificial reservoirs, (2) auxiliary stream plants, and (3) the linking up by transmission lines of the regions with different energy régimes.

The high cost of coal makes operation of thermal auxiliary plants expensive. They are, however, used to some extent, especially in central and southern Italy, where they make up as much as one-fourth of the total. In northern Italy they contribute less than three per cent. For the country as a whole the installed capacity is about 20 per cent steam; but most of the installations were for reserve. Of the actual power generated, steam is estimated to account for only about five per cent of the total.

The use of reservoirs has always been an important feature of Italian hydro-electric development and will naturally become more so as the less desirable projects are exploited. However, the variations in Italian rainfall are so wide that artificial storage sufficient to care for the more unusual or extreme fluctuations is often more expensive than steam plants. The rainfall of Italy for the two years 1923–1924, for instance, is reported as being 30 per cent below normal, so that plants already installed were not able to run to capacity. Even at Milan a rainfall record of over 150 years shows, for example, a variation in October precipitation from 376 millimeters to 4.8 millimeters.[15] Steam plants have the additional advantage of providing insurance against interruption of essential services, such as electric railways, in case of accident to the hydro-electric plant or dam failure.

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[14] Marcello Vinelli: Water Conservation in Sardinia, *Geogr. Rev.*, Vol. 16, 1926, pp. 394–402.

Figure 4, showing the variations in the stream discharge curves in different parts of Italy, immediately suggests the obvious advantage of connecting up the different regions. Thus the power deficiency in the north during the Alpine winter could be made up by drawing current from the northern Apennines. How effectively the two supplement each other may be seen from Figure 6. Rapid absorption of small plants by large corporations has facilitated linking together the latter, and today Italy may be said to be practically covered by a network reaching from the Alps to Sicily (Fig. 2).

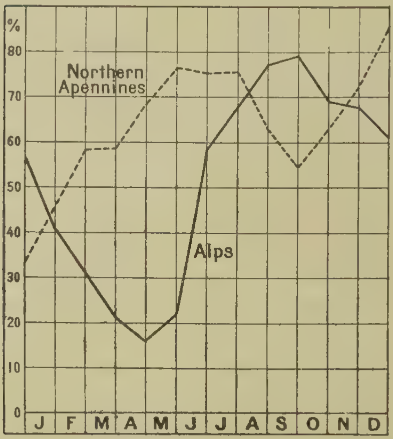

FIG. 6—The hydraulic energy régime for 1925 in the northern Apennines and the Alps. Note the complementary character of the curves: the advantage of connecting the two so as to get a more even flow of current is apparent. Adapted from *Trans. World Power Conference, Sectional Meeting, Basle, 1926*, Vol. 1, p. 351.

MARKETS FOR ELECTRICITY IN ITALY

For what purpose is the electric energy used? As indicated in Figure 7, the greater part finds its way to mills and factories. Actual distribution of the total output among the various groups of consumers does not differ from north to south as much as one might expect. There is, however, a growing tendency for more marked regional differences in the chief use of the available power. Thus in the northern and central provinces power development continues to be primarily for industrial purposes, agricultural benefits being largely incidental. In the south, however, including Sicily and Sardinia, the proposed schemes are giving much more attention to the agricultural aspect. The relatively greater importance of farming as an occupation and the less favorable rainfall conditions in the south are serving to emphasize the agricultural benefits accruing from the utilization of available streams. Construction of dams and reservoirs may be planned not only to provide irrigation during the summer drought but also to facilitate the drainage of extensive areas normally subject to winter floods. This bears directly not only upon the area of tillable land but on the question of disease control in a region long notorious for malaria. Actual electrification of agricultural operations, outside of irrigation and drainage, has been slow in Italy, much slower in fact than in France and Sweden. Cheap labor, conservatism, and ignorance, especially in the south, militate against change.

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[15] G. Motta: The Coexistence of Hydro-electric and Steam-Driven Generating Stations as Affecting the Economy of Production and the Necessities of Storage and Reserve, *Trans. First World Power Conference, London, 1924*, Vol. 2, pp. 238–250.

Of the various types of manufacture one would expect Italy to specialize in those in which power and labor were large elements of cost, raw materials a relatively small item. Metallurgical industries require much, the textiles relatively little power in proportion to the value of the output. However, though textiles require much labor, their high value makes transportation of the raw material a minor item. The situation of the metallurgical industries is just the reverse: the labor factor is small, but the cost of transporting ore and metal is large. As a consequence textile manufacture has played a large rôle in Italian industry. Metallurgical plants have been expanding in spite of, rather than because of, favorable geographical conditions. The world's output of electric steel dropped about 50 per cent from 1918 to 1922, but that of Italy more than doubled in the same period. The increase is due chiefly to the importation of scrap steel, whose use as the basic raw material reduces the power cost by four-fifths, but the industry can hardly compete with that in Germany or Britain without government support.

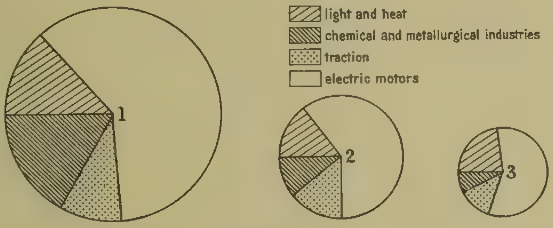

FIG. 7—Energy consumed by régimes in 1925: 1, Northern Italy; 2, Central Italy; 3, Southern Italy and Islands. The total consumption in 1925 was about 7.5 billion kilowatt hours: of this, 15 per cent for light and heat; 60 per cent, motor power; 11 per cent, railway traction; 14 per cent, for metallurgical and chemical industries. From *Trans. World Power Conference, Sectional Meeting, Basle, 1926*, Vol. 1, p. 357.

The actual location of the manufacturing units is in marked contrast with their distribution in the regions of coal. Factories are scattered throughout the Po basin, often situated in the open country, perhaps in a wheatfield or mulberry grove. True, such cities as Milan, Turin, and Genoa are important industrial centers; but there are nowhere to be found the highly concentrated manufacturing districts such as are characteristic of the coal fields of Germany, Britain, or the United States.

ECONOMIC AND POLITICAL ASPECTS

It is interesting to note that Italian hydro-electric development has been sponsored mainly by private capital and initiative. Securities of water power companies are generally regarded in Italy as safe investments yielding moderate returns. In 1923 the average profits of 131 such companies were 6.75 per cent. The government maintains strict control over the development; and concessions are made, at least theoretically, on the basis of merit rather than priority. Further to aid the work there is a hydrographic service which gathers statistics and collects observations from some 5500 stations of various types, including 3800 rainfall and 850 hydrometric stations. A government subsidy of 60 lira per horse power for plants already operating or in an advanced stage of construction to be effective December 31, 1928, has been promised for southern Italy, Sicily, and Sardinia, and one of 40 lira for the rest of the country. The capital invested in electric installations was estimated at the end of 1924 as about three billion lira. Thus it may be seen that the state tax of about nine per cent on the capital nets the government a considerable income.

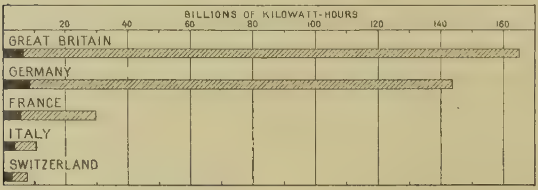

FIG. 8—Power theoretically available in coal and oil production plus that from water power, potential (ruled) and exploited in 1920 (solid black). Data from P. A. M. Nash, *Trans. First World Power Conference, London, 1924*, Vol. 4, p. 1311.

ITALY'S ELECTRICAL STATUS

By the close of 1925 there were all told 588 hydraulic plants operating in Italy. Their installed capacity of over two million kilowatts was larger than that of any other country of Europe. Furthermore, development was still active. Some seventy-nine plants, representing over a million horse power, were under construction.[16] This alone would mean an increase in the total capacity of over 40 per cent in the next few years even if no further exploitation were begun. In addition reservoirs designed to impound 770 million cubic meters of water were being built. The actual saving in terms of coal due to hydro-electric development was estimated in 1924, on the basis of 6.5 billion kilowatts of energy produced, as equivalent to 6.5 million tons, a quantity equal to about one-half of the present annual import.

It may well be asked how much farther the curve of water power exploitation can rise. One estimate, analyzed in Figure 8, gives the amount of energy theoretically available based upon the annual coal and oil output plus the water power, both potential and exploited, in 1920. Italy is shown as consuming about one-third (32.1 per cent) of her total power theoretically available. Both Italy and Switzerland (36.2 per cent) appear to be nearing the limit, assuming that perhaps

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[16] *Commerce Repts.*, April 18, 1927, p. 159.

50 or 60 per cent of the theoretical power may be actually capable of practicable exploitation.

A second estimate, admitted as only roughly approximate, gives the maximum possible hydro-electric power as 14.3 billion of kilowatts. This, the same authority says,[17] would be equivalent to the power obtained from seventeen million tons of coal, or about one and one-half times the maximum coal consumption of Italy for any year up to date.

Comparative costs of water power exploitation have shown a marked tendency to increase. Thus from 1918 to 1924 the cost as measured by the capital investment per kilowatt of plant capacity advanced almost 100 per cent. Naturally, the sites requiring the least expenditure were the first exploited, and the less desirable ones are being developed only with greatly increased investment. It is for this reason that perhaps only 50 to 60 per cent of the power theoretically available may be actually exploited.

In the face of this situation it seems inevitable that there must come very shortly a flattening out of the water power development curve. That change will be hastened as other countries more richly endowed with coal and raw materials, e. g. Germany and France, recover and competition becomes still keener. Italian industry will trend more and more to the types of highly finished goods into whose make-up the labor cost will be a still larger element. One may expect, for example, less raw silk and more manufactured silk garments to figure in her export trade. There is no basic reason why Italy should not complete the whole manufacturing cycle instead of sending the raw silk to be worked up in Switzerland, France, or the United States.

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[17] I. C. Funk, *Commerce Repts.*, May 25, 1925, p. 460.

THE DISTRIBUTION OF POPULATION IN NYASALAND

F. Dixey

Government Geologist, Nyasaland Protectorate

RECKONED by African standards the native population of Nyasaland is large. According to the 1926 census[1] it is 1,290,885, giving an average of 34.6 per square mile, whereas for Tanganyika Territory the density is 11.26, for Northern Rhodesia 3.2, for Southern Rhodesia 5.1, for Portuguese East Africa 7.0. Distribution, however, is uneven. The total area of the Protectorate is about 37,890 square miles, and the population is disposed over it about as follows:

Population Per Square Mile	Area in Square Miles	Percentage Area
201 and over	810	2.3
151–200	480	1.4
101–150	1845	4.8
51–100	5150	13.5
11–50	8350	22.0
0–10	21255	66.0

The areas of densest population are in the Lower Shire valley about Port Herald and the Chiradzulu district and adjacent parts of Blantyre where the native population is over 200 to the square mile. More than one-third of the European population (1656 in 1926) also lives in the Blantyre District, which contains the commercial centers of Blantyre and Limbe; and a little more than one-seventh lives in the Zomba District, which contains the seat of government and also has a large native population. On the other hand the figures show two-thirds of the country with less than 10 inhabitants to the square mile. The northern Nyasaland plateau, for instance, is very sparsely populated. Moreover, this section suffers great losses by the continuous emigration of natives to Rhodesia and South Africa. At the time of the census taking it was estimated that 30,000 Nyasaland natives were absent in these countries; but it is to be hoped that with better farming opportunities in their own country this exodus of the natives will gradually grow less.

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[1] This discussion and the map of population density illustrating it are based principally upon the 1926 Census Report of Mr. S. S. Murray; to some extent also it has been compiled from the information collected by Mr. Murray in connection with the Report, as well as from observations I have myself made from time to time.

POPULATION AND WATER SUPPLY

In the following discussion of distribution emphasis will be laid on the question of water supply, which is intimately bound up with a number of population problems. Such problems include the relief of congested areas; the transference of native villages from areas infested with tsetse fly; the extension of native industries, including the growing of tobacco, cotton, and food crops, and the raising of cattle; the control of emigration; the settlement of labor required on European estates; the extension of forest reserves; and the control of health.

In the Report of the Lands Commission appointed in 1920 due emphasis is laid upon the necessity for providing water in a number of dry areas that are otherwise suitable for settlement. In general, water is not so much needed for agriculture, for which the rainfall is usually sufficient, as for domestic purposes; and this is demonstrated by the alignment of habitations along a network of streams even in areas of uniform soil. Investigation has often shown that supplies for domestic use can be developed at small or moderate cost and that ground-water supplies can often be tapped by means of boreholes and windmills; furthermore, in other areas supplies suited to irrigation purposes are available.

The urgency of the problem is in no small danger of being overlooked for a time owing to the generally improved condition of the streams and of subsoil moisture during the last three years. Owing to the cyclic variations of climate known to affect this part of Africa, these ameliorated conditions may safely be regarded as temporary, and within a few years abnormally dry seasons similar to those of 1920–1924 will doubtless again be experienced. When such a dry period does recur, greatly increased difficulty as to native and other water supplies will very possibly be met as a result of the intervening deforestation and soil erosion. On this point the Census Report is emphatic.

> In many parts of the Protectorate the natives have denuded the land of trees with the natural consequence that streams which formerly ran with reasonably pure water throughout the year have dried up entirely or partially, and the quality of the drinking water, which is often stagnant, has deteriorated enormously. The result has been a notable increase in the incidence of intestinal complaints. . . . It will take many generations to repair the damage that has been caused by the ruthless destruction of forest, even if the evil is reparable at all. In the meantime the water supply of the natives constitutes a serious problem from the point of view of health and the prevention of mortality. The remedy would seem to lie in the construction of village wells, adequately protected from pollution.

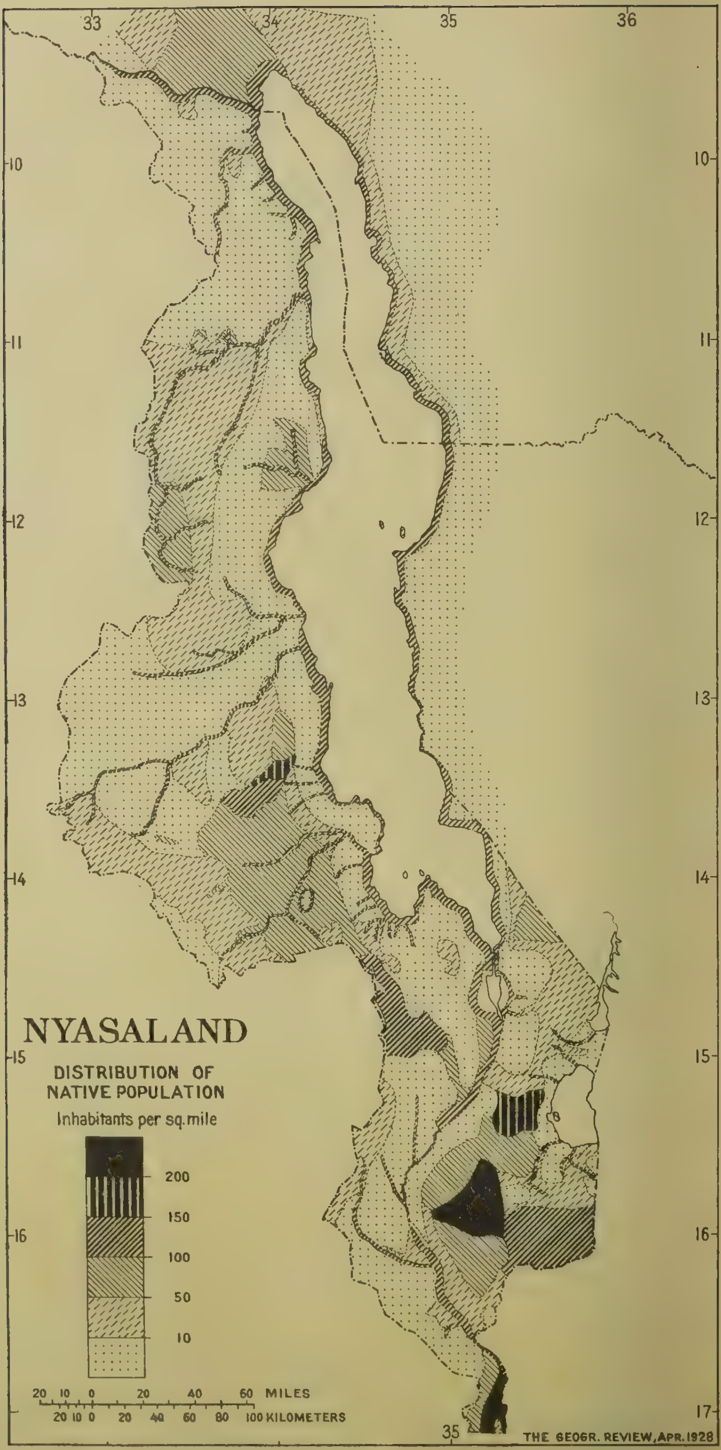
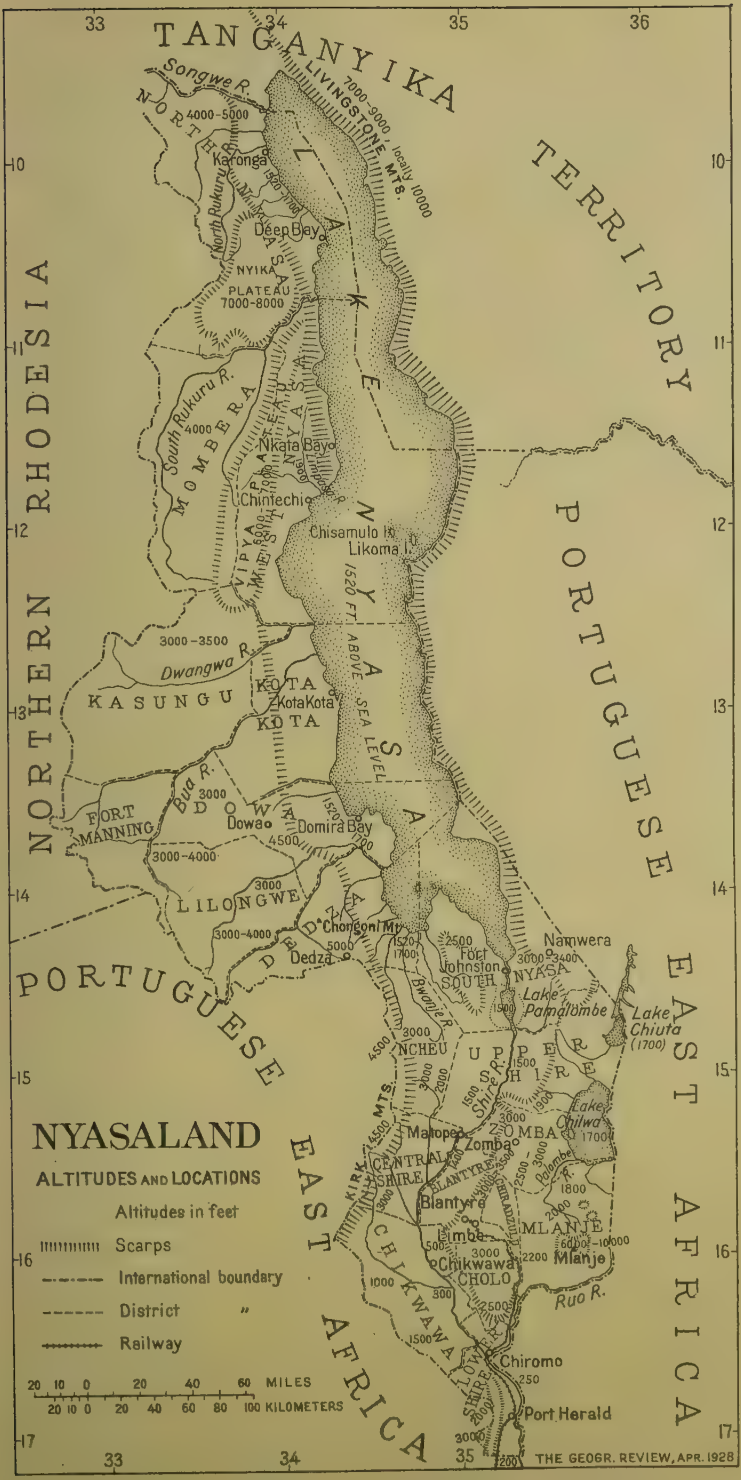

33
34
35
36
10
11
12
13
14
15
16
17
NYASALAND
DISTRIBUTION OF NATIVE POPULATION
Inhabitants per sq. mile
200
150
100
50
10
20 10 0 20 40 60 MILES
20 10 0 20 40 60 80 100 KILOMETERS
THE GEOGR. REVIEW, APR. 1928

FIG. 1—Map of Nyasaland showing distribution of native population according to the census of 1926. Scale of map 1:4,625,000.



THE GEOGR. REVIEW, APR. 1928

FIG. 2—The main physiographic divisions of Nyasaland are defined by hachures and by approximate elevations.

The problem is perhaps more clearly defined in territories that have large native reserves, such as Southern Rhodesia, which during the last three years has expended approximately £20,000, exclusive of overhead charges, upon the water supply of these areas. While native reserves of this kind are not recognized in Nyasaland, yet there exist considerable areas of Crown lands inhabited by natives which would probably amply repay the expenditure of moderate sums in the development of water supplies. They include parts of Angoniland, the southern lake plains, the Bwanje valley, the Upper and Lower Shire, and the Lake Chilwa-Tuchila plain.

Furthermore, in South Africa and in Rhodesia the Government assists in various ways in the provision of water boreholes for European agriculturists and in some cases even makes preliminary trials as to water supply on Crown land before alienating it to settlers. In 1922 South Africa had 40 drills at work, and this number is now greatly increased; Rhodesia is at present operating 10 drills.

The Map of Population Density

Six grades of population density, ranging from less than 10 inhabitants per square mile to over 200, are shown upon the map (Fig. 1). Apart from the areas of densest population it will be seen that the population tends to concentrate along the lake shore and along the larger streams and rivers; in view of the variable densities attained in these places, however, combined with the narrow strips of land involved, it has been found necessary to employ for them a uniform average shading, namely that indicating a density of 101–151, and to exaggerate slightly the breadth of the strips. Where it has been possible to evaluate the population along the lake shore, as around the southern end of the lake and in West Nyasa District, it has been found, on the assumption that the villages concerned occupy a strip averaging two miles in width, that the densities generally range from 90 to 200. Locally, however, as also along the Shire in places, these densities are much exceeded.

In the Census Report the population densities in the sections of certain of the Districts had been evaluated. Since these sections range from 17 to 2978 square miles in area, it is evident, as Mr. Murray observes, that as a whole they are too large to serve as units in a population map. For example, a statement of the population densities of the three sections forming the western side of South Nyasa District affords little clue to the fact that the inhabitants are concentrated mainly along the water side, with a density locally exceeding 200, and to a much less extent on Chilipa plateau; the remainder of the area is thus left with a sparse population, averaging considerably less than 10 to the square mile.

Figures are available[2] showing the native population of the sub-districts of southwestern Tanganyika, of which the average density is 8.7. Although details as to the different parts of the sub-districts are not given, it would appear that along the greater part of the lake shore south of Konde Land there is a narrow densely-populated strip, followed by a narrow lake plain and a scarp (or a scarp only along the Livingstone Mountains) of low density and thence by plateaus with densities of only about 6 to 13, and 13 to 26; these conditions roughly correspond to those of Nyasaland on the opposite side of the lake and would appear to be similar also to those of Portuguese territory along the southeastern shore of the lake.

In the Lower Konde sub-district of Tanganyika, however, along the northernmost shore of the lake between the Songwe River and the Livingstone Mountains, conditions are very different. In this sub-district, with an area of about 380 square miles, the population density approaches 100.

The average number of inhabitants in the villages of the various districts in Nyasaland ranges from a minimum of 57 in Blantyre to a maximum of 259 in South Nyasa; there are only 18 villages with over 1000 inhabitants and only 86 with 500 to 1000 inhabitants. Kota Kota township is formed of a number of villages with an aggregate population of 5438, mostly concentrated within an area of about one square mile. Mponda's village near Fort Johnston is the largest individual village and has a population of 2562. There are only three districts, namely West Nyasa, South Nyasa, and Lower Shire, with any considerable number of large villages. In all three the most fertile areas lie in strips along the river valley or lake shore, and it is not easy to find an unoccupied site.

Physical Divisions and Population

Side by side with the population map is a map showing in diagrammatic form the principal physiographical features of the Protectorate (Fig. 2).[3] The country is traversed from end to end by a deep, broad trough that represents the Great Rift Valley in this region; accordingly, it may be regarded as consisting of three principal features: the floor of the Rift Valley, partly occupied by Lake Nyasa and by the Shire and its tributaries; the scarps forming the walls of the rift, frequently very steep or even precipitous; and the plateaus that border the rift and make up the country on either side. The scarps, as well as certain of the higher plateaus and mountain masses, are roughly indicated upon the map. A branch of the rift runs south-southeastwards from Lake Malombe to Lake Chilwa and thence past the western side of the Mlanje Mountains and along the course of the Ruo valley.

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[2] C. Gillman: South-West Tanganyika Territory, *Geogr. Journ.*, Vol. 69, 1927, pp. 97–131; reference on p. 118.

[3] See F. Dixey: The Nyasaland Section of the Great Rift Valley, *Geogr. Journ.*, Vol. 68, 1926, pp. 117–140.

It is significant that, apart from the Shire Highlands, where a number of artificial factors have helped to develop a dense population, the more densely populated areas on the plateaus and scarps largely coincide with the outcrop of the graphitic gneiss and crystalline limestone series of the crystalline rocks;[4] these areas comprise that part of Angoniland between the southern boundary of Kota Kota District and Dedza, the upland areas bordering the Rift Valley between Dedza and Neno, and the country west of Port Herald.

West and northwest of the graphitic and related gneisses of the southern and eastern part of Angoniland there extends a wide plateau of about 4500 square miles underlain by granites, granulites, and acid gneisses; the disintegration of these rocks has given rise to a great expanse of pale, very sandy soils and subsoils, dry and sterile, that are in great contrast with the red, fertile soils of the graphitic gneisses. Just as these latter soils support the densest population of this region, so the dry sandy soils of the west underlie the largest sparsely populated tract in the whole Protectorate. The somewhat better population of these acid and intermediate gneisses when they are followed northwards to Mombera is probably due to the influence of the Vipya and Nyika plateaus, which enjoy better rainfall and give rise to the South Rukuru River and its numerous tributaries.

The outcrops of the older sedimentary formations are almost wholly unpopulated. These include the Karroo running along the Portuguese border west of Chikwawa and Chiromo, which covers an area of about 800 square miles and consists mainly of sandstones and grits; the quartzites, sandstones, and related rocks of the Mafingi Mountains; and the Cretaceous and Tertiary sandstones and marls that occupy considerable areas between the Songwe River and Florence Bay. The sandstones of the various Karroo outcrops of North Nyasa are also almost unpopulated; contrasted with these the calcareous and clayey rocks of the same period, as in the Nkana and Mpata areas, are well populated; this is doubtless because these latter rocks not only yield better soils but also, owing to a lower resistance to erosion, have formed depressions that receive a fair supply of water from the adjacent uplands.

Wherever the larger alluvial areas are adequately supplied with water they support dense populations, like the populous tracts of Konde Land at the northern end of the lake, those of South Nyasa and the mouth of the Bwanje valley at the southern end, and also other alluvial areas around the lake, as well as in the Lower Shire and the valleys of the larger rivers.

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[4] See F. Dixey: The Geology and Mineral Resources of Nyasaland, *Mining Mag.*, Vol. 34, 1926, pp. 201–212.

The distribution of population by the various physiographic divisions will now be examined in some detail.

The Lake Shore

The term "lake shore" is here used to describe the populated strip of land around the margin of the lake. It is generally about two miles wide but much narrowed where the mountains come down to the lake, as in West Nyasa District. Its high density is doubtless essentially due to the ease with which water and food can be obtained, for not only is fish always available and the curing of fish for sale an important local industry but also two crops of maize can be raised in the year.

Along the Konde coast, north of the Songwe River, the dense population merges into that of the plains behind. The inhabitants of North Nyasa District are largely concentrated along the lake shore. In West Nyasa District 80 per cent of the population lives near the shore, along a large part of which there is a continuous line of huts. The steep mountain slopes here are characteristically continued far below water level, so that the shore platform is discontinuous and largely confined to narrow beaches within a number of small inlets. For instance for a distance of more than ninety miles north of Chintechi there are only two satisfactory anchorages for the lake steamers, namely at Nkata Bay and Ruarwe.

That part of the coast near the northern part of Kota Kota District supports relatively few people, apart from Kota Kota township itself. Southwards, however, the population density tends to increase, so that around the southern end of the lake, on the assumption that the villages occupy a strip two miles wide, it varies from 100 to 200 per square mile, the maximum being reached around the extreme southeastern part near Fort Johnston.

One other part of the lake shore is of interest, namely that around the islands of Likoma and Chisamulo. The total population of these islands, which probably do not exceed 10 square miles in area, is 8818; and, while the average density is therefore great, the actual density along the coast is even greater. This concentration is due to the almost complete absence of vegetation, soil, and water in the interior part of the islands. When they first came under European influence, only about forty years ago, they were well wooded and well watered; now, not only are most of the gardens of the islanders situated on the mainland, but even firewood and poles for huts have to be carried thence across to the islands.

The Lake Plains

The lake plains are highly important for their economic possibilities. They lie principally at the extreme northern and southern ends of the lake and along the western side except where the mountains of West Nyasa rise almost directly out of it. Along the eastern side the lake plains are rarely more than three or four miles in width, and in several places, as along the foot of the Livingstone Mountains, they are absent altogether.

The population of the Konde plains at the northern end of the lake is much higher than that of any other area of similar extent around the lake shore; this is doubtless owing to the breadth and character of the soils that overlie the floor of this part of the Rift Valley and also to the high rainfall—60 to 75 inches per annum. The soils and subsoils of the area are mainly alluvial, and their high fertility is in part due to their derivation from the alkaline lavas and ashes that lie between Rungwe and the Songwe River. Konde Land will doubtless prove to be of great economic importance when Lake Nyasa is finally connected to the sea by rail.

The section of the plains extending from the Songwe River to Florence Bay is about ten miles in average width, although west of Karonga, if the Mwesia valley be included, it is considerably wider. The inner margin of the plain, where it approaches the foothills of the main scarp, is broken by several ridges of crystalline rocks that run parallel with the lake shore; the country between and immediately on the eastern side of these ridges is made up of innumerable steep-sided hills and tables of sandstones, marls, and gravels (the Dinosaur Beds and Tertiary sediments), almost entirely waterless and sterile, apart from a few small patches of alluvium in the valleys. The soils and subsoils are almost invariably coarse and gravelly besides being frequently overlain by a sheet of pebbles and boulders. Apart from the fact that the valleys support a number of cattle and that the sediments contain many deposits of limestones suitable for agricultural and building purposes, the area appears to be of no economic value.

East of this dry, stony, and sterile country, however, an unbroken strip of alluvium stretches from the Songwe to Deep Bay; it is six miles in average width and 60 miles in length and has considerable economic promise. Since the plain has been built up partly from deposits laid down by a number of rivers that traverse it and partly by the action of the lake itself, which has subsequently receded to its present position, it follows that the character and quality of the deposits will vary from place to place and permit the cultivation of a wide range of crops. The soils are usually light and sandy, but they range for the most part from gray and brown medium loams to fine sandy loams; locally, however, they may be clayey or even coarse and pebbly. They are not often deficient in lime, and numerous deposits of limestone are available in the area.

Cotton was grown on the plain until about two years ago, when, owing to the encroachment of the pink boll worm from Tanganyika

Territory, this crop had to be abandoned in order to save the cotton areas of southern Nyasaland. The plain has recently been shown by the agricultural chemist to be thoroughly suitable for the production of tobacco, both bright and dark, and it is probable that this will soon become the principal crop. Bananas form the main food crop along a large part of the coast, but rice is grown locally. Other crops that can be successfully grown include sorghums, maize, millets, beans, peas, cassava, sweet potatoes, sesame, and groundnuts, as well as many grasses of high feeding value.

The population over a large part of the plain averages 30 to the square mile, but it is almost exclusively confined to the lake shore and to the banks of the half dozen rivers that cross the plain. Considerable areas are wholly uninhabited mainly for lack of water. Only the larger rivers, the Songwe and the Northern Rukuru, maintain a steady flow throughout the year; the smaller streams dwindle and disappear after leaving the foothills, although in some cases water can be obtained by excavating in their sandy beds. The interfluvial areas are completely arid for the greater part of the dry season, yet if water were made available upon them they should become as productive as the present well watered areas.

But from the point of view of underground water supplies better conditions could scarcely be desired, since the plain is built up of alluvial deposits that are inclined very gently lakewards from the foot of high plateaus, and the rainfall varies locally from 30 to 50 inches per annum. The inner margin of the alluvium stands at about 160 feet above lake level, and this probably marks the maximum depth at which water would be obtained. Although much could be done locally by means of excavated wells, the depth of the water table and the friable nature of the alluvium would render the work difficult, and conditions on the plains are not suitable for the construction of small earth dams. Boring would afford the easiest and most satisfactory means of obtaining water. It should be remembered that the sedimentary layers of which the plain is built up are probably lenticular in form, so that sub-artesian conditions may be expected to exist.

Mention should be made of the admirable sites for dams in the country immediately behind the alluvial belt. From the point of view of the volume of water that could be impounded per unit cost these sites probably include some of the best in the Protectorate. It has already been mentioned that this belt comprises several crystalline ridges. Through the outer ridges the rivers have cut deep, narrow gorges where easily constructed dams would impound enormous quantities of water that could be used for irrigation.

Included within the lake plain is the Limpasa *dambo* (an open plain) and the low country lying between it and Chintechi. The *dambo* stands but little above lake level, probably less than 150 feet, and on the gentle slopes rising 100 to 300 feet above it stand rubber estates of the African Lakes Corporation. This area, including that traversed by the Luweya and its tributaries, is, apart from the lake shore, the best populated area of its size in northern Nyasaland, doubtless because of its deep rich soils and the high rainfall induced by proximity to the Vipya Mountains. The rainfall, which ranges from 70 to 100 inches per annum, is probably higher than that of any other area in the immediate vicinity of the lake and is more evenly distributed than is the case in most other parts of Nyasaland. The area is exceptionally well wooded. Rubber is grown with considerable success, and parts of the district are considered to be suited to growing of tea and coffee, and it is expected that great expansion will take place as transport conditions improve.

The next part of the lake plain to be described is that traversed by the lower course of the Dwangwa River and that lying behind Kota Kota; possibly also similar conditions prevail between these two places. These areas, together with that lying behind Fort Maguire for a distance of about twelve miles to the foot of the main scarp, are essentially different from the alluvial areas so far described in that they consist of planed-off rocky platforms that slope gently down to the lake shore; solid rocks underlie them at a depth usually of only a few inches, and the soils and subsoils when present are coarse and gravelly. These conditions are similar to those of a large part of the floor of the Shire valley.[5] Such areas are unpopulated like other parts of the lake plain but, unlike them, owing to the absence of good soils as well as water, do not offer any hope of economic improvement.

The remaining part of the lake plain extends to the southern end of the lake and includes the lower Bwanje valley and the lowlands about Fort Johnston; this tract is wholly alluvial and includes some of the best land near the lake. Behind Domira Bay it is about 20 miles in width, south of this somewhat narrower. It closely resembles the North Nyasa coastal plain in general character and economic possibilities, except that it has the additional advantage of being within reach of prospective railway development. As in the case of North Nyasa the population is mainly confined to the lake side and the banks of the larger rivers but is much greater and denser than that of the northern area. The soils of this area are sometimes of extraordinary fertility, for example the land between Ntakataka (Dedza District) and the mouth of the Bwanje, which has been cultivated continuously for many years and usually produces two annual crops of maize. The northern part of the area, particularly in Kota

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[5] See F. Dixey: The Physiography of the Shire Valley, Nyasaland, and Its Relation to Soils Water Supply, and Transport Routes, *Rept. Geol. Survey Nyasaland*, Zomba, 1925.

Kota and Dowa districts, produces much rice, while the southern part is yielding tobacco at a rapidly increasing rate; cotton can be grown over a large part of the area.

The water supply conditions are similar to those of North Nyasa, and here also probably some hundreds of square miles could produce valuable crops if only the underground water supplies were made available. When streams are in process of absorption by the alluvium the water table is a convex surface of which the stream bed forms the uppermost part; consequently, wells put down only a short distance from the stream channel may have to penetrate considerably below the level of the stream before striking water. North of Ntakataka, several miles from the lake shore, two wells were excavated to depths of 90 feet; one struck a little water, the other remained dry. Yet where the land within two or three miles of the lake shore is very low, perennial water may be met at depths of 30 feet or less. Along the inner margin of the plain at a distance from river channels the water table may lie as deep as 150 feet; but, though inaccessible by excavated wells, it could easily be reached by boring.

THE SCARPS AND PLATEAUS WEST OF THE LAKE

The scarp that rises from the inner margin of the lake plain to the plateau above does not call for much comment. Usually, owing to its steepness, dryness, and general rocky character, it is practically uninhabited, even where, as in Dedza District, the plateau area immediately overlooking it is well populated. But where streams emerge at the foot, as along the base of the Vipya Mountains, or where the scarp rises directly out of the lake, as in part of West Nyasa District, there the lower slopes may support a small population. If the scarp is not too steep, however, or if it descends in steps to the lake plain, then quite a dense population may exist, as along the Nchisi Hills in Kota Kota District and for a short distance southwards into Dowa District.

With the exception of southeastern Angoniland and the southwestern corner of Mombera, the population of the plateaus west of Lake Nyasa is very small; apart from the areas named, about half the plateau has a population density ranging from 21 to 26, with one section of Fort Manning District reaching nearly 30 while the other half has a density of less than 10. The Nyika plateaus, covering an area of about 900 square miles and standing at 7000 to 8000 feet, and the Vipya plateau and its northern extension, covering about 1100 square miles and attaining to 6000 to 7000 feet, are both entirely uninhabited.

There can be no doubt that the increasing cold of the higher altitudes, combined with the difficulty of raising essential food crops, is the main reason for the sparse population. The natives strongly dislike the thick mists and drizzling rain that frequently occur at high altitudes for several months in the year. They are unable to withstand the inclement weather largely because they are usually ill-nourished and ill-clad. Tribes differ widely in this respect, however; in the Livingstone Mountains the Wakinga people carry their villages up to heights of more than 8000 feet.

Areas in Nyasaland lying at 4000 to 6000 or 7000 feet need not necessarily remain with little or no population, however, especially where soil and water conditions are satisfactory. Such areas are often thoroughly suitable for European settlement; and it has been the experience in Kenya, in Tanganyika, and to a less extent in Nyasaland that natives tend to follow Europeans to the higher altitudes when suitable provision is made for them.

Mombera is less sparsely populated than the remaining plateaus of northern Nyasaland; the average density for the greater part is 21, but in the southwestern corner this increases to a maximum of 78 in one small section. This is perhaps due to the nearness of the highlands which give rise to a number of perennial streams, while the more densely populated area of the southwest is traversed by the headstreams of the Northern Rukuru and some of its tributaries.

Parts of Mombera afford instructive examples of the great injury that can be done by the indiscriminate destruction of bush. For example, the Kasitu valley, in the opinion of local missionaries of long experience, is passing to desert conditions. Formerly, the area was well wooded, well watered, and densely populated; but in the past few years the Angoni have deforested it by their wasteful methods of cultivation. There is now scarcely a tree of moderate size to be seen, soil erosion is proceeding apace, water is extremely scarce, and the population has migrated in search of moister conditions. In a lesser degree this is true of the country east of Mzimba below the Vipya, and also of that lying north and west of Ekwendeni. Denudation of these areas is so far advanced that even under the strictest control recovery must be very slow.

Referring to the district as a whole the Resident has stated that in the dry season water is very scarce, and the people have frequently to walk miles from their villages to obtain it from the sandy beds of streams. This is important since Mombera forms with North Nyasa a very important cattle area, the two districts containing half the cattle of the whole Protectorate. In ordinary circumstances a shortage of water is bad enough, but in a cattle country it is incomparably worse.

It is expected that with improved transport an important industry in hides and skins will develop in the northern part of Nyasaland; but in many areas, particularly in Mombera and northern Kasungu, it will be restricted by the shortage of water unless steps are taken to preserve and develop the supply. In many cases a beginning can be made by the excavation of wells and the building of earthen dams, the success of which has been demonstrated by the mission stations at Loudon and Kasungu; but in the flatter and more open areas boring will have to be undertaken.

As regards east-central Angoniland, the densely populated tract west and north of Dowa lies mostly from 3000 to 4000 feet, while the less densely populated area immediately to the south also lies mainly from 3000 to 4000 feet, except near Dedza and along the western margin, where it locally reaches 4500 feet. Dedza itself stands at 5000 feet, and this is the highest inhabited part of the district; nevertheless, many of the natives now living there are attached to the various European stations, although the area was populated and to a great extent cleared of timber before the settlement of Europeans.

As regards the southern area it has been necessary, owing to the scale of the map, to give a shading indicative of the average density; but actually, as in other parts of Nyasaland, the inhabitants tend to gather along the rivers and other places where soil and water conditions are favorable; elsewhere only a very sparse population exists. For example, the higher altitudes of Chongoni Mountain, which rises to a height of 8000 feet, are quite uninhabited, whereas the well watered country immediately around its foot is far more densely populated than are the neighboring areas. Much of the land to the east is too mountainous and rocky for habitation, but it is of importance in augmenting the water resources of the adjacent areas; elsewhere, however, particularly about Lilongwe and westwards along the Fort Manning road, there are wide sparsely populated areas that include land well known to be of great agricultural value, especially for the growing of tobacco. The principal cause of this dearth of population is scarcity of water, but there appears but little doubt that much of the country could be adequately watered at moderate cost.

The Lakes and Lake Plains of Southern Nyasaland

A dense population is aligned around Lake Pamalombe, especially on the western side. This lake, however, is liable to great fluctuations of level; for example, it now extends over fully a hundred square miles, but three years ago it was completely dry. As the waters were receding year by year, the native rice and maize gardens were established farther and farther from the old lake shore; then when the lake rapidly rose again, owing to the erosion of a barrier in the bed of the Shire at the point where it enters the lake, all these gardens were destroyed and a local famine ensued.

Lake Chilwa and Lake Chiuta differ from the other lakes in that their margins are almost entirely unpopulated; this is due partly to fluctuations of level and partly to the nature of the ground, which is locally either very sandy or very clayey and unsuited to the growing of the ordinary food crops; moreover, the waters of Lake Chilwa at least are slightly brackish. Nevertheless, where relatively high ground exists near the lakes, as along the low east and west ridge that runs between them, native villages tend to become established, largely because of an important trade in dried fish which is sold on the Shire Highlands. This is true of Chilwa Island also, which has a population density of a little more than 100; the island is high and rocky, with a narrow plain around the margin; and on it the people have the advantages of dry land on which to build their huts and make their gardens, timber and fresh water from the mountain, and abundant fish from the lake.

Southwest of Lake Chilwa, on the low watershed between the Palombe and Tuchila Rivers, there is a large area subject to inundation. Much good agricultural land lies along the belt within which the gentle slopes of the Shire Highlands merge into the almost level plain; this land is considered of great promise for the growing of bright tobacco; but unfortunately much of it is waterless, particularly towards the end of the dry season when water is required for tobacco nurseries.

The Shire Valley Plains

The Shire valley plains, apart from the river and lake shores and the area south of Port Herald, are but sparsely populated. In an earlier account of the Shire valley[6] it has been shown that the soils and subsoils of the Shire plains fall into two well defined classes, according as they occur on the alluvial areas or on the gently undulating rocky areas, and a map was published showing the distribution of these two classes. The upper Shire between Fort Johnston and Matope and the lower Shire between Chikwawa and Port Herald traverse broad alluvial plains, whereas the middle Shire between Matope and Chikwawa traverses wide rocky plains on which the soils, when present, are almost invariably thin and stony. The Bwanje valley is similar to the upper Shire valley as regards soils and general structure.

The dry, sterile, and stony areas are of no appreciable economic use, except here and there where small patches of alluvium exist near the river banks and it is not surprising that they are very nearly uninhabited. The dearth of population on the broad interfluvial areas of the alluvial plains is explained by the absence of adequate supplies of water. The amazing fertility of the alluvium when water is available is exemplified by the lower Shire area below Port Herald, which is the most densely populated part of the whole Protectorate; over an area of 125 square miles the average population density exceeds 300, so that here the soil is probably carrying the maximum number of inhabitants. This area, however, lies between the Shire on the one side and the Port Herald Hills on the other, and at the foot of the hills a number of small streams occur; moreover, the area is low-lying, and in addition it is traversed by the Ndindi Marsh, in which water is available all through the year.

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[6] Dixey, The Physiography of the Shire Valley.

It is practically certain that all the broad alluvial lands of the Shire and the Bwanje valley could be adequately watered by means of boreholes of moderate depth, probably about 100 feet on the average. Moreover, it has been demonstrated that in many places water is available within reach of excavated wells; and amongst the foothills that frequently limit the alluvium on either side numerous good sites exist for the construction of dams for irrigation purposes.

The lower Shire area is now the most important center of native cotton growing, but the inadequacy of the water supply sets a limit to the expansion of the industry.

THE SCARPS AND PLATEAUS

In general the scarps separating the Shire valley plains from the neighboring plateaus are but poorly populated, as in the case of the scarps of northern Nyasaland; this is chiefly because they are usually very steep and sometimes even precipitous and frequently also dry. In the two areas, however, in which they are of moderate slope the case is different; in the Ncheu area the scarp falls to the plain partly by several broad steps and partly uneven slopes; and here, where good residual soils and fair water supplies exist, the population density is 112; in the Blantyre-Matope area, where moderate slopes again are found, the population density is about 60; and along the foot of the slope, where there are better soil and more water, it rises to 85. The scarps forming the eastern and southern limits of Cholo District are also fairly well populated.

The low scarps of the Chilipa plateau separating the upper Shire from the Bwanje valley are unpopulated; but on the little plateau itself, about the feet of Pirolongwe, there is a good cluster of villages.

While the lofty Mlanje plateau[7] is uninhabited, the lower plateaus of southern Nyasaland, including Namwera, part of the Ncheu area, and the Shire Highlands, comprise some of the more densely populated areas in the Protectorate. The dense population of the Ncheu area lies mainly at 2500 to 3500 feet; but along the slopes of the Kirk range and northwards towards Mlangeni, apart from places of European occupation, it locally attains to 4000 feet, or even, in the more sheltered places, to 4500 feet. The dense population of the Chiradzulu-Blantyre area lies mainly between 2500 and 3000 feet, although locally approaching 3500 feet.

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[7] See F. Dixey: The Mlanje Mountains of Nyasaland, *Geogr. Rev.*, Vol. 17, 1927, pp. 611–626.

The denser native populations are very largely due to the presence of the European towns and estates, which have arisen essentially because of the generally good soil and water conditions, as well as the favorable climate. In some of these areas, however, particularly in the Chiradzulu and Blantyre districts, the native population is highly congested, so that in a number of places the land is supporting its maximum number of inhabitants. Conditions have been rendered much more difficult in certain areas owing to the ruthless deforestation that has taken place in recent years, and this applies particularly to Chiradzulu District.

Relief of congestion in the Blantyre and Chiradzulu areas is made almost impossible by the absence of water in neighboring areas that are otherwise suitable for native settlement; a little has been done by excavating wells, but the question urgently requires more active measures than have been possible in the past.

The question of water supply is a very serious one also for the European towns of Blantyre and Limbe; the most hopeful measures rest in the demarcation of suitable collecting grounds combined with the establishment of local forest reserves.

SOME POPULATION GRADIENTS IN THE UNITED STATES

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A JOURNEY of a hundred miles in any direction almost anywhere in the country—even in the corn belt—will reveal to the traveler, if he has eyes, noteworthy differences in population density, differences due fundamentally, if not wholly, to variations in topography, fertility, and climate. Usually the transition from high to low density of population is gradual, but it is frequently sudden.

One of the sharpest density gradients in the world, and one most obviously caused by topography, exists within the metropolitan area of New York City, where the densely populated strip west of the Hudson—the highlands and lowland covered by Jersey City, Hoboken, Weehawken, and smaller towns to the north—lies immediately contiguous, with no transition zone, to the uninhabited tidal marshes of the Hackensack meadows. This illustration, however, is somewhat obvious. Similar sharp transitions may be noted around other cities, especially those on low-lying coasts.

AN EXAMPLE FROM TEXAS

A better example, because it involves rural as well as urban population, is to be found in Texas. From Waco, south through Austin, runs a fairly sharp and continuous line of faults, producing what is known in general as the Balcones Escarpment. It separates the fertile Black Waxy Prairies on the east from the Edwards Plateau on the west and marks in part of its course an extremely sharp population gradient.

East of the Balcones Escarpment lies one of the greatest cotton producing districts in the country, if not in the world—a region of deep black soil, prairies that billow in broad folds a mile or two from crest to crest, fine towns, good roads, and a population of relatively high density. Its productivity and wealth are indicated by a row of thriving towns and cities, Fort Worth, Dallas, Waxahachie, Waco, Temple, Georgetown, Austin, San Marcos, New Braunfels, and San Antonio.

West of the Escarpment rises the Plateau, much dissected in its eastern part and consisting of limestone hills and ridges separated by the dry beds of rocky streams, box canyons, and narrow valleys in which there is only an occasional old flood plain of alluvial soil. The hills have either a very thin and rocky soil or none at all and are covered with a growth of scrubby juniper, known locally as cedar, Spanish oak, and miscellaneous chaparral. There is a rapid run-off of rainfall, and during the summer what soil there is is burnt to dry powder. Along the few streams farming is here and there possible, and pecan growing will doubtless develop into a profitable industry locally, but in the main the bulk of this eastern and rougher part of the Edwards Plateau is wholly unfit for farming. For many miles west of Austin the sparse population, consisting mainly of poor whites, known locally as "hill billies," who eke out a slender existence by hunting, charcoal burning, and hauling firewood, attests the poverty of the soil and the unfavorable topography. Within three or four miles of the capital of Texas, a city which unofficially now lays claim to a population of 50,000, one can enter country which is to all intents uninhabited. A few years ago a mountain lion was shot within sixteen miles of the Capitol dome, and deer are sometimes met with even closer. Yet the density of rural population eastward from the base of the Balcones Escarpment rivals that of Illinois.

The sharpest contrast, both in topography and in population density, between the Black Waxy Prairie and the Plateau, is to be found between Round Rock and New Braunfels. Between Round Rock and Austin the transition is made in a few miles, in some places scarcely a mile, from the densely populated farming land to the practically unpopulated hill country. The difference in elevation, while abrupt, is not great, the Balcones Escarpment being marked on the landscape by a line of low-lying hills. The prairie country in the Austin quadrangle averages perhaps 600 feet in elevation, while the neighboring plateau region ranges from 700 to 1200 feet, rising steadily toward the northwest. There is not an abrupt difference in rainfall, although in this part of Texas the isohyetal lines are fairly close together and run almost due north and south.[1] The line of 30 inches of average annual rainfall follows roughly the 99th meridian, and on a population map of Texas a noticeable density gradient roughly follows the same meridian. The abrupt difference in density between the hill region and the prairie is not due to difference in precipitation, however, but to soil and topography, and these in turn to geological formation.

Recent decades have demonstrated that cotton can be grown profitably on the plains of western Texas, even in parts of the Llano Estacado, and far up in the Panhandle, where the winter temperature may touch zero and where the average annual rainfall is but little over twenty inches.[2] But between the Black Waxy Prairie of central Texas and these far western high plains lies the immense region of rough and broken country comprised by the Edwards Plateau, the Central Mineral Region, or Granitic Hills, and parts of the Grand Prairie and the Western Cross Timbers. In this rough country neither soil nor topography is suitable for much else than goat and cattle ranching.[3] The lower capacity of the rough country, as compared with the Black Waxy Prairie, to support population is indicated in Table I and the map, Figure 1. On a small scale it is shown on the dot map of the rural population density of the United States appearing in the Atlas of American Agriculture.[4]

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[1] Atlas of American Agriculture, Part II, Section A, Precipitation and Humidity, U. S. Dept. of Agriculture, 1922, pp. 6, 7.

TABLE I—POPULATION DENSITIES OF CERTAIN TEXAN COUNTIES

PLATEAU			PLATEAU-PRAIRIE			PRAIRIE		
	TOTAL	RURAL*		TOTAL	RURAL		TOTAL	RURAL
San Saba	9.0	9.0	Bell	42.9	28.0	Falls	48.6	42.8
Lampasas	11.9	11.9	Williamson	38.0	30.2	Milam	39.7	35.3
Burnet	9.8	9.8	Travis	57.4	22.6	Lee	24.9	24.9
Llano	5.5	5.5	Hays	25.6	18.3	Bastrop	30.7	27.0
Gillespie	9.0	9.0	Comal	15.8	9.4	Caldwell	49.2	41.9
Blanco	5.4	5.4	Bexar	160.0	32.2	Gaudalupe	39.4	34.2
Kendall	8.0	8.0				Wilson	21.3	21.3
Medina	8.6	8.6				Fayette	31.0	31.0
						Gonzales	27.9	24.8
						Lavaca	30.5	26.4
						De Witt	31.8	25.0

*Excludes the population of towns of 2500 and over.

The population gradient between the Black Waxy Prairie and the timbered red soil region of eastern Texas is not so pronounced or abrupt but it is none the less noteworthy. Here again soil fertility is the main factor, though other conditions enter in to counterbalance the more copious rainfall of the eastern part of the state. The eastern topography is flatter and lower. The Trinity, Brazos, and other rivers have broad flood plains; the local drainage is poor; and there are many swamps and sloughs. This part of Texas, like great areas in Arkansas and Louisiana, is afflicted with malaria. It is possible, also, that the relatively less dense population of this eastern part of the state has historical causation in the fact that it was easier for the settler to go on to the open prairies than to stop here and clear the timber.[5] Other sharp density gradients in Texas are to be found in the lower Rio Grande Valley, along the Pecos, and about El Paso. The first two cases are due to irrigation, and the last is due to the presence of an urban center plus irrigation.

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[2] Atlas of American Agriculture, Part V, Section A, Cotton, U. S. Dept. of Agriculture, 1918, pp. 8–10. Since 1910, cotton production has been extended still further than shown in this publication. Cf. Statistical Atlas of the United States, 1924, p. 410.

[3] Atlas of American Agriculture, Part V, Section A, p. 8.
Bonney Youngblood and A. B. Cox: An Economic Study of a Typical Ranching Area on the Edwards Plateau of Texas, *Texas Agric. Exper. Sta. Bull. No. 297*, 1922.

[4] Part IX, Section I, Rural Population, 1919, p. 4 (distribution of the rural population in 1910). Cf. Statistical Atlas of the United States, 1924, pp. 139, 140 (density in 1920, but not a dot map).

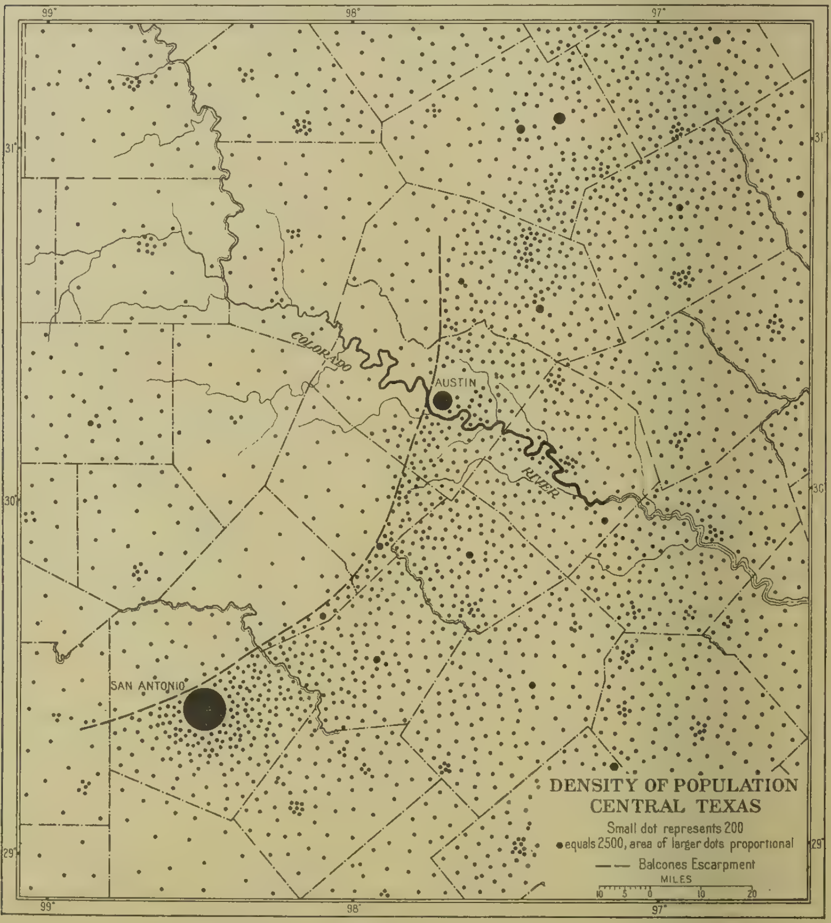

FIG. 1—Map showing contrasts in population density between prairie and plateau counties in Central Texas. Scale approximately 1:2,500,000.

It would be interesting to speculate to what extent these sharp gradients will be affected by future population movements. Between 1910 and 1920, census figures indicate high percentages of increase in the south and along the Gulf Coast, in eastern Texas, in the Panhandle, and on the plains south of the Panhandle; while the whole central region, including the Edwards Plateau, the Grand Prairie, and the Black Waxy Prairie itself, suffered heavy losses, especially in rural population.[6] It is safe, however, to predict that the Balcones Escarpment will continue for an indefinite time to mark a very steep population gradient.

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[5] Cf. F. L. Olmsted: A Journey Through Texas, New York, 1857.

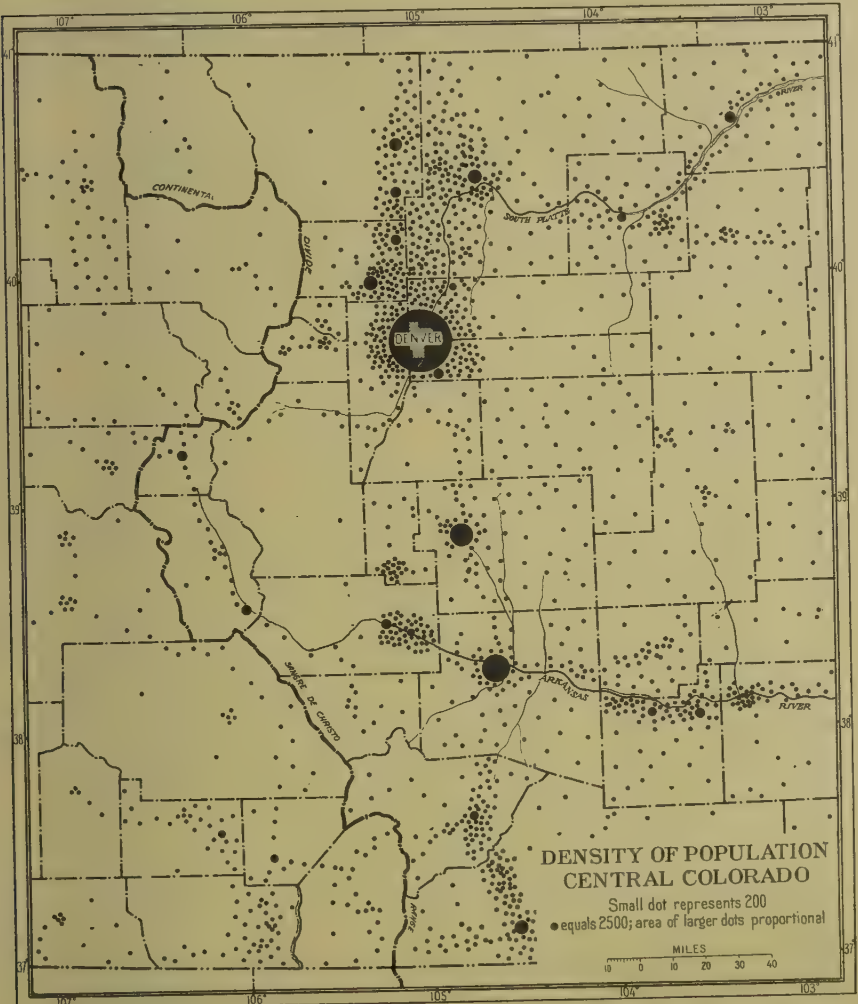

FIG. 2—Map showing contrasts in population density in the Front Range region of Colorado. Scale 1:3,750,000.

The Front Range Region of Colorado

In Colorado are cases of sharp contrast due to irrigation, as along the Arkansas and South Platte rivers (Fig. 2). Other cases are due to urban centers and to topography. The sharpest gradient in Colorado, and one of the sharpest in the whole country, is that between the thickly populated irrigated districts north of Denver immediately east of the Front Range and the mountain region to the west (Fig. 2). The Continental Divide, with a magnificent rampart of peaks from Estes Park southward, here approaches to within a few miles of the plains.

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[6] Statistical Atlas of the United States, 1924, pp. 81, 82.

Outside the mining towns and a few health and tourist resorts, the mountains have no cities, and on the plains of eastern Colorado there are only two or three towns of considerable size until we come within sight of the Rockies. As in Texas, so here, we have a north-and-south row of prosperous towns and cities just to the east of the mountains. This line of urban communities extends from Cheyenne and Laramie on the north, through Greeley, Fort Collins, Boulder, Denver, Colorado Springs, Pueblo, Canyon City, south to the coal towns of Walsenburg and Trinidad.

It is as if the westward movement of population had thrown itself against the ramparts of the Front and Sangre de Christo ranges and recoiled, to settle in chance valleys and depressions at the base of the mountains. It was not all chance, however. Very little study of the early history of the region would suffice to show a relation of each urban center to strategic passes—e. g. Berthoud and Rollins back of Denver, the Royal Gorge and Tennessee Pass back of Pueblo and Canyon City, or to natural resources, like coal in the south and water for irrigation in the north. Yet apart from historical beginnings it is difficult to see exactly why a great industrial center should have developed at Pueblo or why Denver a hundred miles from the routes of the central transcontinental lines, the Union Pacific at Cheyenne, the Santa Fe and the Rio Grande Western at Pueblo, should have become the metropolis of the state.

Most of these Front Range towns, as they may be called, from Colorado Springs north, depend for their prosperity to some extent upon the summer tourist trade. But for this their population would be smaller and the density gradient, both to the east and to the west, would be less pronounced than it is. As long as there are railroads and automobiles and people with money to travel, the climate and natural beauty of this region will be assets tending to maintain the present gradient. The remarkable density of population of the plains immediately east of the mountains and north of Denver, in Larimer and Boulder counties and the western part of Weld and Adams counties, however, is due to the fact that this is one of the most successful irrigation districts in the country, with a high productivity in fruit, vegetables, and sugar beets. The agglomeration in eastern Fremont county, where the Arkansas River emerges from the Royal Gorge, is due to similar causes.

THE LOWER PENINSULA OF MICHIGAN

In Michigan an interesting population gradient unfolds between the southern and northern halves of the Lower Peninsula. In the south, diversified farming, prosperous towns, dense population; in the north, barren wastes of sand covered with scrubby second growth where once the great white pine forests stood—a region now of extremely dubious agricultural possibilities, a problem to the state,[7] and not likely soon to have any considerable permanent population, but capable of yielding considerable profits to speculative land companies who now are offering swampy lake frontage at fifty dollars a front foot. The present density of this part of Michigan is in fact not greater than parts of the Edwards Plateau in Texas. Roscommon County, only 150 miles from Detroit, has a density (3.1), which matches that of regions of little promise in far west Texas.

CONTRASTS IN SOUTHERN ILLINOIS AND EASTERN TENNESSEE

In Illinois and Tennessee we find unexpected reversal of the general rule that plains have high density, provided there is adequate rainfall, and the hills and mountains a low density. In the hilly country of southern Illinois, Williamson and Saline counties have rural densities of about 75 and 85 per square mile respectively—comparable to the densities of the counties tributary to the industrial districts about Chicago, Peoria, and St. Louis. The high density of these southern Illinois hill counties is due to coal mining and fruit growing. The density of the total population of Jo Daviess County in the extreme northwest—also a rough country and formerly a mining region but now no longer so—is only 35 per square mile.

In the mountains of eastern Tennessee,[8] where only a small portion of the land is in crops, there is a region of high density juxtaposed to one of low. The high density here must be attributed to the fact that this is the region of "our contemporary ancestors," among whom contentment with a "hog and hominy" standard of living, coupled with an Elizabethan conception of the proper size of families, conduces to unlimited procreation. The same low standard of culture and absence of family limitation obtain among the "hill-billy" part of the population of the Edwards Plateau in Texas, but they have neither the soil nor the rainfall to support the density that obtains in eastern Tennessee. Families may be just as large, but they are few and far between.

A MORE REFINED STUDY IN TEXAS

These are but samples of the interesting phenomenon of the population density gradient. So far as the present writer knows, little attempt has been made to study it in detail. Unless it be from personal observation, which can usually give no basis for accurate statistical comparison, we know little about local, but often very significant, density gradients in this country. The maps in the Census Bureau's Statistical Atlas for 1920 (Pls. 69, 72–118), showing population density by counties, have two shortcomings. The numerical grouping of densities (less than 2, 2 to 6, 6 to 18, 18 to 45, 45 to 90, and 90 and over, per square mile) is too rough, and the density is represented by a uniform tint for the whole county, whatever the actuality. An adequate study of local density gradients requires not only the requisite census data of population but also topographical and political maps of sufficient detail and on a sufficiently large scale. In most cases the topographical sheets of the United States Geological Survey should be adequate, if they happen to exist for the area being studied. A serious difficulty, however, is encountered in the fact that political administrative units, by which census population is tabulated, do not always correspond to topographical features. Thus the Balcones Escarpment in Texas cuts across the middle of several counties (Fig. 1). If, therefore, we wish to map population densities above and below (west and east) of the Escarpment with meticulous accuracy, we must have statistics by units smaller than counties.

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[7] Cf. M. M. McCool and J. O. Veatch: Sandy Soils of Southern Peninsula of Michigan, *Mich. Agric. Coll. Exper. Sta. Special Bull. No. 128*, January, 1924.

[8] Atlas of American Agriculture, Part IX, Section I, Rural Population, p. 4.

Volume I of the 1920 Census of population gives county populations by townships, boroughs, justice precincts, and other minor civil divisions, the unit and title varying with the state. The standard Federal land survey township is six miles square; but in some states, e.g. in Texas and the Atlantic states, there is no standard shape or size. We have nothing to show the areas or locations of the numbered civil districts in Tennessee counties, for instance, or the justice precincts in Texas. For a dot map of population we do not need the areas of these local divisions, but we must know their approximate boundaries. Although the Census tabulates population by local civil divisions within the counties, the Census Bureau has on file no information with regard to the location of these divisions. Despite this curious lack of local geographical information on the part of the Census Bureau, one could, with a sufficiently large library of local political maps, make an accurate study of local population distribution—provided the maps showed the location of the minor civil divisions, within the county, by which the Census data are tabulated and provided no changes in the boundaries of these divisions had been made between the Census date and the map date.

Unless the investigator is on the ground of the region being studied he will inevitably encounter great difficulty in obtaining the necessary information as to the location of the minor civil districts. For this information he will have to appeal to county officials, and it will often be given in a form difficult to utilize.

Returning to our Texas illustration, we have the following Census data for the total population of Travis County (1920) by justice precincts:

Precinct 1	1,874
Precinct 2 including Manor town	5,916
Precinct 3 including part of Austin City	34,579
Precinct 4	3,221
Precinct 5 including part of Austin City	3,330
Precinct 6 including part of Austin City	7,570
Precinct 7	505
Precinct 8	621

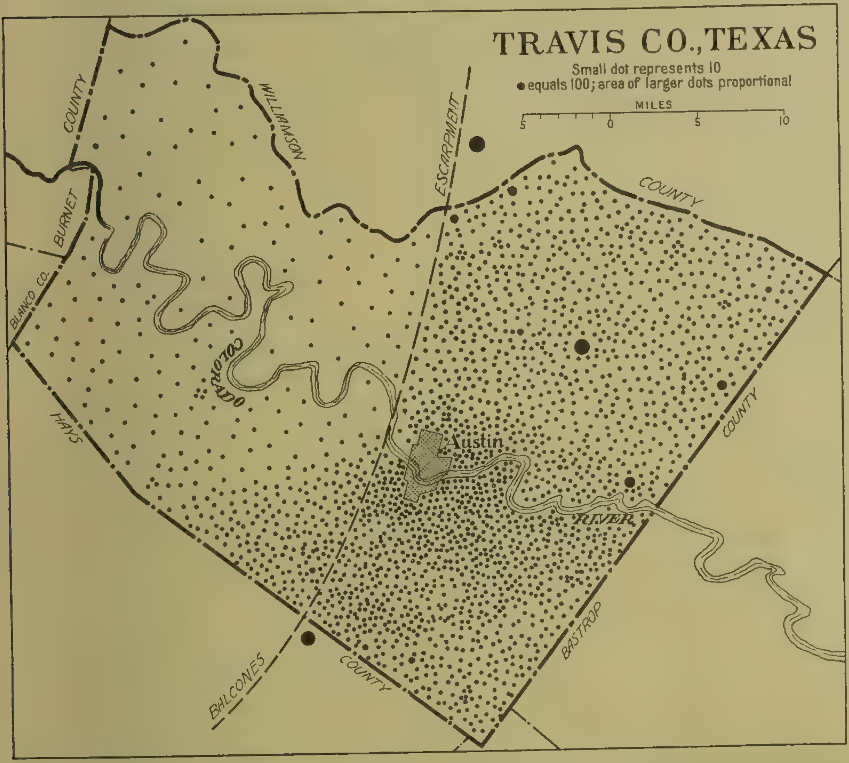

FIG. 3—Map of Travis County, Texas, showing effect of Balcones Escarpment on distribution of population. Compare Figure 1.

Each of these justice precincts consists of a number of election precincts, 58 in all, the boundaries of which are minutely described in a sixteen-page pamphlet issued by the County Commissioners, and defined by reference to ancient land grants (not given on any ordinary civil map), local roads, railroads, creeks, etc. It is practically impossible for a person who is not actually on the ground accurately to locate these precincts. The following, from the Travis County Commissioners' Court, "Order Re-establishing the Several Election Precincts," 1924, is one of the simpler and plainer of the descriptions:

> Beginning on the Travis and Bastrop Counties' line at a point from which the northeast corner of the Wm. Hines League bears South 60° E.; then north to Hines' League corner and continuing in the same direction with the north line of said Hines' League, and with the road to the northeast corner of the Kimbro League; thence northwest to the Cele and Lund road; thence westwardly to the Manda and Manor road; thence south to the Kimbro and Manor road and to the southwest corner of Mrs. Schieffer's farm; thence east to another Kimbro and Manor road; thence southwardly with the said road to the Houston and Texas Central Railroad; thence with said railroad to the line of the counties of Bastrop and Travis, and thence northwardly with said county line to the place of beginning.

The dot maps, Figures 1 and 2, were constructed without attempt to use the Census figures by justice precincts. Figure 3, showing on a larger scale the distribution of population in Travis County, is the result of an attempt to utilize the above figures for justice precincts. It was impossible to get the exact location and extent of these precincts, but a sufficiently close approximation was arrived at to indicate what is believed to represent with considerable accuracy the distribution of the rural population of the county. Even using the population data by precincts, however, it was found necessary to fall back on personal acquaintance with the territory concerned, since certain precincts straddle the Balcones Escarpment. Figure 3, thus constructed as accurately as the nature of the available data permits, brings out graphically the sharp gradient at the Balcones Escarpment in Travis County. The distribution of rural population as shown in Figure 3 may be compared with the topography of the region about Austin, as shown in the topographical survey map of the Austin quadrangle. It is safe to say that the density of the rural population of the rough part of the county west of the Escarpment is not over 2.25 per square mile, while that of the eastern, or prairie, half of the county is probably close to 40 per square mile.

It goes without saying that for purposes of visual comparison of densities, and for locating on a map the population where it actually is (instead of spreading it uniformly over a unit area), dot maps are generally superior to other devices. Geographically a most instructive map would be one with contours in one color and population dots in another, both printed legibly on the same sheet. As Vidal de la Blache says:

> If detailed statistics of population are compared with equally detailed maps, such as are available in almost all the principal countries of the world today, it is possible, by analysis, to find a connection between human groups and physical conditions. Here we touch upon one of the basic problems of human population. For the existence of a dense population—a large group of human beings living together in the smallest space consistent with certainty of a livelihood for the entire group—means, if one stops to think of it, a victory which can only be won under rare and unusual circumstances.[9]

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[9] Paul Vidal de la Blache: Principles of Human Geography, transl. by M. T. Bingham, New York, 1926, pp. 14, 15.

These circumstances—of climate, topography, and fertility—have not been so rare and unusual in the United States as in some other parts of the world; but it is clear, however unable the population optimists may be to understand the fact, that further expansion of population into districts of less favorable topography and humidity can be made only as a result of pressure, of dynamic cultural change, improvement of technique in the extractive industries for instance, and with some diminution, if expansion goes too far, of certainty of livelihood at the present standard of living.

The examples of population gradients here given, and their relation to the basic topography, suggest a fertile field of coöperative research among American geographers, agricultural experts, and students of population. Ultimately may we not look forward to a population-and-resources survey comparable in detail and scope to the Geological Survey?

IRRIGATION SYSTEMS OF PERSIA

Commodore B. Fisher

American Boys' School, Hamadan, Persia

> IN this tract of country there is no water appearing on the surface, though there are many subterranean channels which have well-shafts sunk to them, at spots in the desert unknown to persons unacquainted with the district. A true account of these channels has been preserved among the natives to the effect that, during the Persian ascendency, they granted the enjoyment of the profits of the land to the inhabitants of some of the waterless districts for five generations, on condition of their bringing fresh water in; and that, there being many large streams flowing down Mount Taurus, these people at infinite toil and expense constructed these underground channels.

Thus Polybius described the problem of water supply in Persia, and so it is today.[1] *Kanats*, as the underground channels are known, are characteristic signs of a Persian village. Leading down from the mountains to the numerous villages scattered about the interior basins are long lines of dug wells, rimmed about by the dirt that has been removed and resembling in appearance the shell craters of the battle fields of northern France. The wells are about twenty yards apart, and most of them are rimmed around with earth and rock to a height of three or four feet. The well itself, sometimes as deep as one hundred feet, is neatly walled up and frequently covered with large flagstones and loose dirt. These are the only outward signs of the tediously constructed underground tunnels that collect life-giving water for a dry and thirsty land.

The dryness of the Iranian plateau is well shown in Professor de Martonne's maps of aridity and interior-basin drainage in the July, 1927, number of the *Geographical Review*, to which reference should be made. The great part of the plateau has only interior drainage. Winter snows on the lofty ranges give rise to turbid streams in the early spring, which dwindle away with the coming of summer. During the season when they are full some use is made of this water for irrigation. Hundreds of ditches have been constructed on the mountain sides to carry this surface water miles away in different directions. With only an eye for the lay of the land and the persistent use of crude hand-forged picks and shovels the mountaineer lays out the system on a trial and error basis. As the dry season advances most of the surface streams dry up, but deep underground seepage continues to supply brackish water to the swampy oases on the basin floor. To bring this underground water to the surface and distribute it over the thirsty land that lies between mountain and swamp is the problem solved thus anciently by systems of underground channels. The method is widely used among the desert peoples of the Old World,[2] and it has been introduced into the New World.[3]

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[1] The Histories of Polybius, translated from the text of F. Hultsch by Evelyn S. Shuckburgh, Bk. X, Ch. 28 (Vol. 2, p. 27). See also James Morier: A Second Journey through Persia, Armenia, and Asia Minor, to Constantinople Between the Years 1810 and 1816, London, 1818. Morier describes the construction of channels on pp. 163–164.

CONSTRUCTION OF THE KANAT

The construction of the *kanats* is usually a professional matter. The digger begins excavation on a gentle slope and gradually works underground. Aiming at some dry river bed or other depression, the tunnel, about two feet wide and four feet high, is extended on up toward the mountains. The bed is kept almost level, and stone and dirt are removed through the regular series of wells. Day after day with only the flickering light from a crude grease lamp the excavators crouch down in the mud and water under an unsupported ceiling dripping from overhead seepage. With an eye to detect water-bearing strata the master workman digs ahead while his helper fills his goat-skin buckets and drags them to the last well or opening. Here a third workman uses a large reel or windlass to draw the bucket to the top. The chief obstacles encountered are the great boulders that in times past have rolled down the mountain side and become embedded in the soil of the plain. They are overcome with characteristic patience. When they occur in the path of the tunnel it is easy to curve around them. When they are encountered in the middle of a well the boulder must be turned to one side. Another difficulty is presented by strata of soft dirt. Here stones must be lowered and the tunnel walled up on both sides and covered over with closely fitted flagstones.

As the work progresses and the tunnel passes deeper and deeper underground, water-bearing strata are reached. Here the course is changed to intercept the seepage; or, better still, laterals are dug out from the main tunnel. Then forward again with other branches, until a network of five miles or more, with as many as 500 wells, has been completed. The wells in reality are comparable to manholes in an underground conduit system, yet they may be used as real wells from which water is drawn from the tunnel stream.

WATER FOR DOMESTIC PURPOSES AND IRRIGATION

The amount of water furnished by one of these *kanats*, varies with the amount of water supplied by natural seepage and with the skill with which the *kanat* has been fitted to the natural lay of the land. The waste-covered mountain slopes act as a great reservoir, holding back the water that soaks in with every fall of rain and snow. Such seepage as this furnishes a country home with an ample water supply if only one well is dug. But a tunnel dug at the same depth will supply as much as thousands of wells dug side by side. These tunnels, for the most part privately owned, provide artificial streams large enough to turn an old-fashioned water mill.

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[2] Jean Brunhes: La géographie humaine, 3rd edit., Paris, 1925, Vol. 2, p. 599.

[3] Isaiah Bowman: Desert Trails of Atacama, *Amer. Geogr. Soc. Special Publ. No. 5*, New York, 1924, p. 20.

The stream, as it emerges from its underground source, is usually led on down through the village to furnish drinking water for man and beast. It is also convenient for washing clothes, and the village butcher finds it to be a good place to wash his meat, as well as to dump his refuse. The energetic landlord may utilize the banks of the stream to grow trees for building purposes; and the stream itself may furnish him a fish supply. If he has an eye for beauty he may lay out by the stream long drives between tall poplars and willows, bordered with arbors of roses and lilac.

Having watered and cleansed the community, the water passes out beyond the village into the real irrigation ditches, usually raised above the level of the alluvial plain. These elevated grass-covered ditches render the use of modern agricultural machinery impracticable. The small plots they enclose are plowed up with a yoke of oxen and an iron-tipped forked stick. After breaking up the ground, three men use a very wide ridging spade which is pulled by ropes attached to either end. In this way a network of ridges is thrown up that hold the water in level patches on the ground. With this poor seed bed and practically no further cultivation excellent crops of wheat and barley, poppies, melons, and vegetables are grown. During the growing season the farmer's chief task becomes that of turning in the water. A few shovels of dirt change the course of the stream from ditch to ditch so that the water is spread out over the growing crops once every week or ten days. Methods of dry farming might well be introduced, but that would require more work. So the farmers are content to continue the old methods, which require little more than directing the flow of the water.

Problems of Ownership and Maintenance

Such systems as here described cost thousands of dollars to construct, even though the master workman receives only one dollar a day and his helpers less than half as much. The wells are a real obstruction to good cultivation, while irrigation directly over a tunnel causes an expensive cave-in; hence a thirty foot right of way is usually kept open as waste land above the entire *kanat* system. Then too the constant seepage into the *kanat* drains the surrounding ground and renders it less productive.

Because of the expense and the difficulty of coöperative effort on the part of small landowners, these irrigation systems are privately owned and tend to perpetuate the feudal system which is well organized in Persia today. A wealthy family can purchase an extensive tract of desert land, make a large investment in a water system, and attract hundreds of tenants who are eager to make their homes around the water supply. Under the need of water and the difficulty of securing it, these tenants are easily reduced to virtual slavery.

Once constructed, the *kanat* guarantees the prosperity of both overlord and peasants as long as it is kept in repair. The village will continue to increase in size and beauty till future generations come to accept their prosperity as a matter of course, giving little attention to the maintenance of the source of all their prosperity. Finally some scion of the ruling family is afflicted with the wanderlust, disposes of surplus carpets, grain, and flocks, and spends a season in Paris. At the same time the old *kanat* is fast falling into decay. The tillable ground ceases to bear fruit, the fields are caught up in the desert again, and the village drifts along more dead than alive. Finally, leaving a water supply hardly sufficient for the private gardens of the ruling family, the villagers move away, going to the city to pick up a precarious living or making a new start in life by joining themselves to other villages.

Systems in the Cities

The *kanat* systems of the larger cities have expanded with the city's growth. The lines of wells, each marking the route of one of the artificially constructed watercourses, reach out on the upper side of the city like the spokes of a wheel, bringing the water down into different sections. Considerable friction frequently arises in the competition for water, and constant vigilance is necessary. Secret laterals may be dug out from one main tunnel to undermine another *kanat* that provides a good water supply. Obstructions may be placed in the wells, and worse still are the pools which are constructed in private gardens through which the water flows as it nears the surface. Where the stream is within about ten feet of the surface, wealthy citizens may build their houses directly over it and excavate a large basement down to the level of the water. This vaulted room with its tiled floor and walls, pools for washing dishes, clothes, and fruits, and special place for bathing adds much to the value of the property. Delightfully cool retreats these are in which to rest from the blistering sun; but it is well not to look too closely at the gurgling stream lest its charm pass away. The water, clear as crystal, may now become murky with tea leaves from some neighbor's party. Then greasy water from the dinner dishes or suds from the family wash may follow in close succession. So, one ceases to relish the running spring water which the host lifts proudly for his refreshment. Even the fruit, beautiful and good as it may be, loses some of its charm when lifted from a cooling bath in this priceless stream.

After running through a dozen or more of these vaulted basements the stream comes to light. It is then divided into *dongs*, or sixths, as is the Persian practice for the division of ownership in water or real estate. One yard may have water rights of one-half *dong* three times a week, more or less, as stated in the deed to the property.

Practically every courtyard has its open pool through which the surface stream flows as it passes through the city. When water is scarce it is a decided advantage to live at the head of the stream. Here the pool may be frequently emptied and then refilled with the water that should pass on to the neighbor's yard—a kind of "tax" that is collected for permitting the water to pass through one's property. Not uncommon are the more flagrant abuses of the gentleman's agreement that permits the water to arrive at some distant yard. It becomes necessary to employ a special guard to sit at the head of the stream. Yet, for a small consideration, he too may permit a "break" in the ditch which would drain off a third of the water that should arrive at the garden. If he is an expert a watchful guard may close the break before the owner appears or, if caught, may smooth it over with profuse apologies for his neglect and repeated assurance that it has just occurred.

When properly cared for, the partnership *kanats* which supply the cities with water are inspected and cleaned every fall. Yet group ownership frequently leads to neglect, because that which should have been everybody's business becomes nobody's business; and then a large assessment is necessary to make essential repairs. These more extensive repairs are usually opposed by some shareholders whose funds are low, but the law of the land favors the man who would keep the *kanat* in repair. After giving due notice of intention to make needed repairs, the partners may go ahead with the work and withhold water rights from defaulting partners until bills are paid.

With the introduction of modern methods into Persia we might expect the construction of large reservoirs to be fed by the *kanats* that flow into the city. From these reservoirs water mains could be laid out to the different parts of the city, thus assuring the people a purer supply. Water mains through the long tunnels would simplify the repairing of crumbling *kanat* walls but would not permit the seepage along the way. It will be many years before we discover a better way to collect the underground seepage and water a city. As the Roman aqueduct was suited to the hills and valleys of a country with numerous springs, so the *kanat* of the Persians fits the physical features of their dry interior basins.

TRANSPORTATION DEVELOPMENTS IN CENTRAL AFRICA

M. Warthin

THAT interior part of Central Africa comprising Katanga Province, Northern Rhodesia, and Nyasaland possesses in its natural resources a vast wealth whose development has scarcely begun. A mineralized belt containing tremendous tonnages of high grade copper ore lies on both sides of the Katanga-Northern Rhodesia boundary. The holdings of the Union Minière de Haut-Katanga, a Belgo-British concern, which include most of the known deposits in Katanga, consist of separate ore bodies scattered over an area approximately 200 miles long and 20 to 70 miles wide extending from Chilongo to Elisabethville. It seems "likely that Katanga is really the greatest copper field ever opened."[1] North of the Katanga copper zone lies a second mineralized area containing tin and gold. Katanga, moreover, possesses sufficient radium to supply the markets of the world and by agreement with Canada divides equally with that country in the annual production of cobalt. Across the border in Northern Rhodesia recent prospecting has given good results, and "it is now an accepted fact that a copper field of great significance exists along the Northern Border, extending at least 150 miles in a north-west and south-east direction and having a breadth of not less than 50 miles."[2] A healthful climate, timber suitable for most purposes, and potential water power encourage commercial development.[3] The labor situation is improving as an increasing number of natives become resident in the district. With the completion of the construction work on the railroads and at the mines a large number of natives will become available for productive labor. It is estimated that the substitution of coal for wood in some of the mines will release 4000 wood cutters.[4]

Exploitation of these minerals has been retarded in the past by the difficulties involved in transporting them to tidewater. Although the region lies within the watersheds of the Congo and Zambezi Rivers, communication is impeded by rapids, irregularity of flow, or shoals.[5] This remote area was finally opened to world markets through the medium of the railway. A line by way of Broken Hill and Elisabethville reached Bukama, head of navigation on the Congo, in 1918. The products of this interior region now reach the coast at several South African ports or at Beira in Mozambique. Freight for export can also be shipped by water from Bukama to Kabalo, by rail to Albertville, by ferry across Lake Tanganyika, and thence by rail to Dar es Salaam. In 1926, the Katanga Railway routed 64,500,000 kilograms of copper via Beira and 16,300,000 kilograms by Dar es Salaam.[6] Thus, although its markets are in western Europe this region is forced to a costly export via the east coast of Africa.

Two railroads destined to play important rôles in the development of Katanga and

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[1] J. R. Finlay: Copper, *Foreign Affairs*, Vol. 4, 1925, pp. 123–133.

[2] Northern Rhodesia, Rept. for 1925–26, *British Colonial Repts. No. 1363*, p. 16.

[3] O. Letcher: Katanga and Its Mineral Development, *Engineering and Mining Journ.-Press*, Vol. 119, 1925, pp. 277–284: G. L. Walker: What is the Future for African Copper?, *Engineering and Mining Journ.*, Vol. 123, 1927, pp. 401–403.

[4] S. H. Ball: Belgian Congo Grows in Mining World, *Engineering and Mining Journ.*, Vol. 125, 1928, pp. 197–200.

[5] On the situation and physical character of the region and the relation to exploitation see Maurice Robert: Le Katanga Physique, Brussels, 1927.

[6] *Congo et Bull. Soc. Belge d'Études Colon.*, Vol. 1, 1927, pp. 679, 680.

Northern Rhodesia are nearing completion. The more important of these, popularly known as the Benguella Railway, will link the port of Lobito in Angola with Chilongo in Katanga. Begun in 1905, its progress has been impeded by the international aspects of the project, but this spring the Portuguese section of the line will be opened officially. Recent rapid construction has been made possible by an agreement between the Belgian and Portuguese authorities arrived at in the summer of 1927. By the terms of this convention, Portugal engages (1) to equip the port of Lobito so that it may handle its traffic efficiently and (2) to put freight of Belgian origin on a plane of equality with that of Portugal. In return Belgium undertakes to complete the railway from the Angola boundary to the Katanga Railway at Chilongo within five years after the arrival of railhead at the border. As the route is already surveyed and the material ordered, construction on the Belgian section should proceed apace. An exchange of territory was also agreed on. Belgium cedes to Portugal the district known as the Dilolo Boot, comprising 3500 square kilometers (see Fig. 1). In exchange Belgium obtains three square kilometers in the vicinity of Matadi and an understanding as to the utilization of the waters of the M'Pozo River. The unequal size of the territories exchanged is offset by the fact that the smaller area is vital in the reconstruction of the railway between Matadi and Leopoldville. The addition of the three square kilometers means a saving of a year's time and 12,000,000 francs.[7]

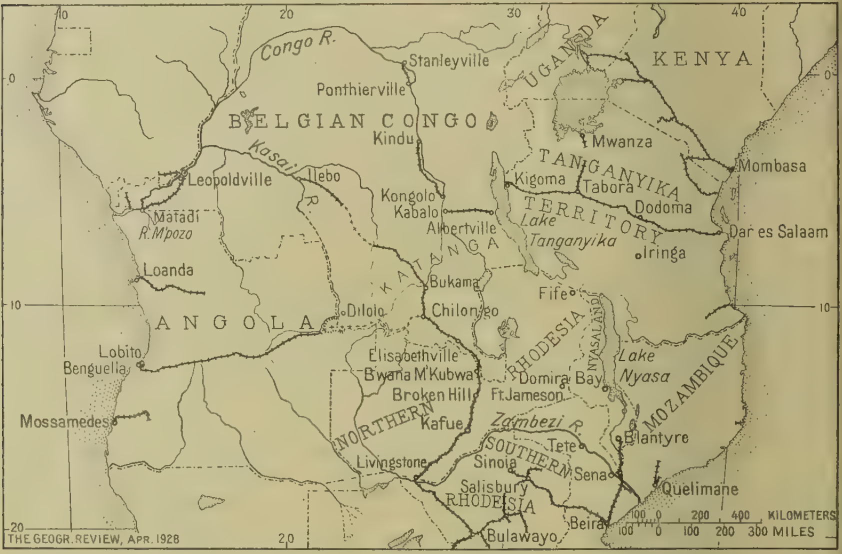

FIG. 1—Sketch map to show the recent railroad developments in Central Africa. The straightening of the Angola-Katanga frontier south of Dilolo is also shown. Scale approximately 1:37,500,000.

The great importance of the Benguella Railway lies in the fact that it provides, for Katanga and Northern Rhodesia, a direct all-rail route to tidewater several hundred kilometers shorter than that by Dar es Salaam or Beira. Distances from Elisabethville to the sea including transhipments are estimated thus: to Lobito, 2179 kilometers; to Matadi, 2609 kilometers; to Dar es Salaam, 2670 kilometers (4 transhipments); to Beira, 2765 kilometers (2 transhipments). Construction of the Kafue-Sinoia cut-off would, however, reduce the Beira route to 1806 kilometers.[8]

Lobito, in addition to being an excellent natural harbor, is located on the west coast of Africa thus shortening the trip to the European markets and avoiding the Suez Canal tolls. Since the line generally follows a watershed route it will be free of many of the "rainy season" troubles of its competitors. As the track is of standard South African gauge (3′ 6″), continuous rail travel will be possible between the Cape and Lobito. Although connection with the Katanga Railway will result in a great increase in its traffic, it must not be assumed that the Benguella Railway is without other resources. In the wake of the railroad's slow progress across Angola, an important agricultural development has grown up within 50 miles of each side of the track. This is significant for, although this railway will long remain the best route between Katanga and Europe, a competing all-Belgian line is already under construction. This route, approximately 400 kilometers longer than the Benguella Railway, comprises a continuation of the Katanga Railway from Bukama to Ilebo (Port Francqui) on the Kasai River, water transportation to Leopoldville, and railway to the port of Matadi. The last rail of the Bukama-Ilebo section was laid on February 13, 1928. Four 800-ton stern-wheelers are ready for the run between Ilebo and Leopoldville. Eventually it is hoped to link Ilebo and Leopoldville by rail, and, as the earthworks on the rebuilt section between Matadi and Leopoldville are so constructed that relaying the track will serve to convert it to the standard South African gauge, an unbroken journey may then be made from the Cape to the mouth of the Congo.[9]

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[7] *L'Afrique Française*, November, 1927, pp. 470–472.

[8] *Congo et Bull. Soc. Belge*, Vol. 1, 1927, p. 642.

The agricultural districts of eastern Northern Rhodesia and Nyasaland are not aided by these two new railroad enterprises. The sole railroad serving these regions runs only as far north as Blantyre, and its efficiency is seriously reduced by the lack of a bridge at the Zambezi crossing.[10] Little is known of Nyasaland's mineral resources, although recently attention has been called to the coal of the Lower Shire and the bauxite of the Mlanje Mountains.[11] Much of Nyasaland and eastern Northern Rhodesia is suitable for diversified agriculture; but in general cotton, tobacco, and tea, grown under the plantation system, are alone of sufficient value to bear exportation. The Katanga mining communities are dependent on the country to the south for their food supply, and in consequence a small district along the railroad in Northern Rhodesia is given a local market for produce that could not stand the charges of a longer haul. Maize is here handled by a coöperative society having a large contract with the mines. Cattle to the value of £46,000 were shipped to the Belgian Congo from Northern Rhodesia in 1926.[12] Native agriculture is largely confined to crops for local consumption and in order to obtain ready cash large numbers of natives are forced to seek employment in the mines or in the agricultural regions to the south. Such migrations will continue until native-grown crops can enter the export field. Settlement has been retarded. Of 1113 electors in the last voters list of Northern Rhodesia, 901 live in the railway zone and 105 in the Fort Jameson district, an important center of tobacco culture connected with Broken Hill by a motor road.

A bridge across the Zambezi at Sena will relieve the transportation situation in Nyasaland. If the coal deposits at Tete and on the lower Shire can be used at Beira for bunker coal, thus providing a bulky immediate source of traffic over the bridge, most of the objections to the cost of the project will be removed. Eastern Northern Rhodesia is even more isolated. Road connections with the railway to the west and with Lake Nyasa to the east are under construction, and the country would share the benefits of the various improvements proposed on the lines to Beira, including construction of the suggested Kafue-Sinoia cut-off. Eventually the best outlet would seem to be by Dar es Salaam via the proposed line from Dodoma to Fife.[13]

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[9] *Ibid.*, pp. 630–648.

[10] *Geogr. Rev.*, Vol. 16, 1926, p. 501; *Rev. Econ. Internatl.*, Vol. 19, 1927, p. 81.

[11] See F. Dixey: The Mlanje Mountains of Nyasaland, *Geogr. Rev.*, Vol. 17, 1927, pp. 611–626.

[12] Northern Rhodesia, Rept. for 1925–26, *British Colonial Repts. No. 1363*.

[13] Imperial Shipping Committee: Rept. on the Harbour of Dar-es-Salaam, Tanganyika Territory, Cmd. 2917, 1927.

TWENTY-FOURTH ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

During December 28, 29, 30, and 31, 1927, the Association of American Geographers met in Nashville, Tenn., for its twenty-fourth annual meeting. Headquarters and accommodation for meetings were provided by the George Peabody College for Teachers. M. R. Campbell, of the U. S. Geological Survey and President of the Association, presided. The general belief that the attendance is affected when meetings are held away from the more densely settled centers was not realized; and the papers were delivered before groups averaging well in numbers those of the Philadelphia meetings of last December.

The Mississippi River Symposium

One of the important series of papers at the meeting was delivered before a joint session of the Association of American Geographers, Section E of the American Association for the Advancement of Science, and the American Meteorological Society, on problems relating to the Mississippi River. In this symposium, three papers discussed the floods, two dealt largely with forecasting, and three with other aspects of the river. H. C. Frankenfield, senior meteorologist of the U. S. Weather Bureau at Washington, with a paper on "Floods of the Mississippi from a Meteorological Standpoint," pointed out that the probability of a flood higher than that of 1927 was very remote, but he admitted that such an occurrence was possible. R. M. Williamson, of the Nashville Weather Bureau, spoke on "Floods on the Cumberland River and Lows That Produce Them," and W. E. Barron, of the Cairo Weather Bureau, on "The Gathering of the Waters and the Changing Régimes of the Mississippi and Ohio Rivers in the Cairo District."

I. M. Cline, forecaster in charge of the New Orleans center, in a paper on "Floods and Flood Forecasting in the Lower Mississippi" showed how the Weather Bureau were able to save many lives by predicting danger spots in the flood plain area and emphasized how, because of the lack of topographic maps of some of the flooded sections, relief was delayed. "The Flooding Rains of April in Relation to the Weather Map Situations," by N. H. Bangs and C. F. Brooks, was presented by Mr. Brooks, completing the second part of the series.

H. H. Bennett, in "Some Aspects of Soil Erosion in the Mississippi Basin," stressed the tragic waste of soil, aggregating in extreme cases forty tons of soil per acre per year. R. M. Brown presented a paper on "The Utilization of the Waters of the Mississippi River," in which the main points covered the domestic use, particularly the restraint of the waters from the home sites, and the use of the river for navigation. W. H. Haas closed the symposium, speaking on "Some Neglected Studies in the Mississippi Flood Problem."

The discussion of the papers was interesting and at times spirited. There was a tendency to break away somewhat from the themes of the papers to the engineering problem of flood control. This is not strange since, after all, what the engineer is going to do to bring any degree of security to the inhabitants of the flood plain is the crux of the problem.

A Field Trip and Papers on Field Work

The introduction of a field trip during the days of the meeting, a procedure inaugurated last year at Philadelphia, was continued; and the entire day of Friday was devoted to an excursion to the Highland Rim and the Cumberland Plateau. This study was under the leadership of a committee consisting of A. E. Parkins, Chairman, K. C. McMurry, and Robert S. Platt. The general program of the Association may be carried on in any locality, and up to the present the only reason for changing the place of meeting has been based upon a rough attempt to average the mileage traveled by the members. With a continuation and expansion of the field discussions, there will be added inducements to meet in localities not generally visited by the Association.

Under the heading of field work, two significant reports on methods may be mentioned. Preston E. James presented an extensive series of maps as the result of his work in the Blackstone Valley, "The Blackstone Valley of Massachusetts, a Type Study in Southern New England Landscape." The general map displayed the utilization of the land, and the detailed maps brought out more clearly contrasted urban and rural areas. A ready following of such a paper is difficult, however, since no uniformity prevails in the symbols used in mapping such information.

The report of a fortnight in the field as an introduction to the year's work at the School of Geography, Clark University, Worcester, Massachusetts, was given under the general title of "A Geographical Survey of the Greenfield, Massachusetts, Area." The work on the physiography and the physiographic evolution was described by W. W. Atwood; that on the land utilization by W. Elmer Ekblaw; and the climatology by Charles F. Brooks. A fourth paper in the series on the industrial studies in Greenfield and Turners Falls, accredited to Clarence Jones, was briefly covered by W. W. Atwood. As in the previous paper, the maps were difficult to follow because of "homemade" symbols. The work was carried on in the Connecticut Valley in Massachusetts about eighty miles from Worcester, and for the period the students were encamped on an abandoned farm. The field work was directed definitely towards such a study of the area as would yield to the people there living some additional knowledge of their surroundings that could be capitalized.

Papers at Other Sessions

Since the geographer today believes that the true field of his endeavors lies in the realm of regional geography, it is not surprising that the bulk of the papers of the meeting were of this nature. S. van Valkenburg (introduced), from a long experience on the island of Java, gave a careful analysis of the conditions obtaining there in a paper on "Java and Overpopulation" and emphasized particularly the outlook for the future in the face of a rapidly increasing population. The standard of living in Java is upward in spite of the increase, and this indicates that the overpopulation threat is really not yet overshadowing. Measures are being instituted to postpone overpopulation by increasing the productive areas and by more intensive cultivation. Neither manufacturing nor emigration can be looked upon as a possible solution. The papers of Robert S. Platt, "Field Study of an Iron Range Community: Republic, Michigan"; of Glenn T. Trewartha, "A Regional Geographic Study in Eastern Shizuoka Prefecture, Japan"; of W. Elmer Ekblaw, "Resources and Industries of Danish Greenland"; and of Roland M. Harper, "Some Regional Statistics of Ages and Families in Alabama" illustrate the breadth and scope of the offerings.

Apart from the papers in the symposium, two meteorological papers were presented, both by Oliver L. Fassig: "Rainfall in the West Indies and Adjacent Areas of Central and South America" and "Some Characteristics of Tropical Climates." Papers on the content of geography and allied topics have been remarkably absent from the program of the Association during recent years, possibly because such papers have a more ready response in the meetings of the National Council of Geography Teachers. The retiring president frequently draws from this field, as was the case this year. Another paper in this category was presented by C. C. Huntington (introduced) on "Geography as a Social Science." In the same way the purely physiographic paper is becoming a rarity, "Glacial Land Forms in the Sierra Nevada, Near the Southern End of Lake Tahoe" by Wellington D. Jones representing alone this branch of geography. Mr. Jones described an almost unreported region of peculiar interest.

A very interesting and suggestive paper was offered by Mark Jefferson, "The Geography of Railway Transportation in 1920–27" in which maps of the railroads of the continents were shown as bands twenty miles wide. The map of Europe thus constructed located all places in Central Europe within ten miles of a railroad. This area, the "map web," stopped abruptly at the Pyrenees and the former Russian boundary. A similar condition appeared for the eastern United States with the exception that the transition from the densely railed sections to the less dense was gradual.

Altogether forty-six titles, not counting the presidential address, appeared upon the program. Three papers were read by title, four were not given because of absences, and thirty-nine were presented. The annual dinner on Wednesday evening was a joint session with Section E of the American Association for the Advancement of Science and was held in Scarrett College. At this time two addresses were given: that of G. H. Ashley, retiring Vice-President of Section E, on "Geology and the World at Large," and of M. R. Campbell, retiring President of the Association, on "Geographic Terminology."

Two members of the Association died during the year. The memorial to Charles Redaway Dryer was read by C. C. Colby and that to Ruliff Stephen Holway by V. C. Finch.

National Council of Geography Teachers

The thirteenth annual meeting of the National Council of Geography Teachers was held on December 27 and 28 at George Peabody College for Teachers. At the annual dinner on Tuesday evening, Robert G. Buzzard, the retiring President, gave his address on "A Type of Field Work for the Training of Teachers." Following this address, D. C. Ridgley gave the story of the first college cruise around the world, "Around the World on the S. S. Ryndam," and W. W. Atwood explained from the teacher standpoint the experiment with field work undertaken at Clark University.

The Tuesday morning session had for a general topic courses of study and methods in Teacher Training institutions, and the Wednesday morning session was devoted to types of presentation. At the Tuesday afternoon session E. E. Lackey spoke on "Imparting the Philosophy of Geography to Teachers"; R. H. Whitbeck on "The Making of a Geography Teacher"; and Mark Jefferson on "A Systematized Pronunciation of Place Names." This organization has become within its brief existence a very thriving group, and the discussions and papers cater to many who have no connections with other organizations.

R. M. Brown

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of December and January. The regular monthly meeting of the American Geographical Society was held on December 20, 1927, at the Engineering Societies Building, 29 West 39th Street, President Finley in the chair. Mr. James L. Clark of the American Museum of Natural History gave an account of the journey of the Morden-Clark expedition from Bombay to Peking in 1926, "Across the Snows and Deserts of Asia." In search of natural history collections the expedition penetrated the Russian Pamirs and Chinese Turkestan, eventually crossing Mongolia, where the members were held captive for a time, to the Trans-Siberian railway. The lecture was illustrated by motion pictures of unusual interest.

The Annual Meeting of the Society was held on January 24, 1928, at the Engineering Societies Building, 29 West 39th Street, President Finley presiding. After the reading of the annual report of the Council (printed below) an address was given by Dr. Matthew Stirling on "An Airplane Expedition to the Pygmies of New Guinea," an expedition made under the auspices of the Smithsonian Institution and the Dutch Government. The Stirling New Guinea Expedition spent eleven months in the jungle, part of the time living with the pygmies and taking motion pictures of the details of their daily life. To reach their country an airplane was employed, and thus the expedition avoided the hazards of river navigation and the dangers of travel among hostile savages that had halted earlier expeditions.

February Meeting and Presentation of the Charles P. Daly Medal to Professor Alois Musil. At the meeting of the Society held February 21 the Charles P. Daly Medal of the American Geographical Society was presented to Professor Alois Musil of Prague, in recognition of his contributions to Arabian geography and history through 30 years study, during which many seasons were spent in the field. The results of Professor Musil's intensive labors are being made known through the interest of Charles R. Crane, Esq., who has enabled the Society to undertake their publication. In presenting the medal President Finley spoke as follows:

"When Doughty, the traveler (who fifty years ago was out in the region of which we are to hear tonight), returned to Damascus, pacing the long street called Straight, he met an old friend who said: 'Tell me, since thou art here again in the peace and assurance of Allah and whilst we walk, as in the former years, toward the new-blossoming orchards full of the sweet spring as the garden of God, what moved thee, or how couldst thou take such journeys into the fanatic Arabia?'

"We put a like question tonight to our distinguished guest who has wandered in the same desert places and still others, but we think of it rather as 'Araby the Blest' whose winds 'blow Sabean odors.'

"From my own slight experience in camel riding I think that our guest's journeying of 13,000 miles on camelback is an achievement of the first order. These ships of the desert are never in a calm except when they are at anchor. There is the incessant rocking as of a ship in a high sea. I suppose that after a time one does become accustomed to the motion and overcome the *mal de chameau*, but I have great initial respect for a man who has sailed halfway round the world (in distance) in such a craft and most all the way over desert sands. So I put Dr. Musil in a class with the world's great aviators and navigators.

"But his title to fame is not the distance he has traveled or the manner of his travel, but the wisdom with which he has observed what he has seen in his travels and the linguistic ability and the intellectual zest which enabled him to interpret what was written in many languages, from the cuneiform inscriptions to modern Arabic, including on the way Greek, Latin, and Syriac. As one of whom Ovid spoke: 'He delighted to wander in unknown places, the labor being lessened by his zeal for information.' To describe in American geographical terms the area which he covered: it would extend if superimposed on the United States from New York City to the eastern boundary of Indiana and from the northern boundary of North Carolina into the forests north of Montreal.

"This region is of universal interest because it includes what he believes to have been the Garden of Eden and Mt. Sinai, the wilderness route of the exodus of the Children of Israel and the Land of Midian whither Moses fled from the face of Pharaoh, kept the flocks of his father-in-law Jethro, and saw behind the mountain the burning bush that was not consumed. It also includes the home of Bedouin tribes, to the mightiest of which he was admitted and made a sheik—a real sheik.

"Charles M. Doughty, the author of that monumental work, 'Arabia Deserta,' said that the books of the Turks and the Arabs 'were men's faces and their living experiences of mankind.' It is such books that Dr. Musil has read afresh and translated into the six volumes which, by a generous subvention from the Hon. Charles R. Crane (whose son is here tonight), the Society has been enabled to publish. In their content they will deserve lasting companionship with Doughty's two volumes telling of the Bedouin's life, of which Colonel Lawrence says: 'It has air and winds, sun and light, open spaces and great emptiness'—yet an emptiness in which every individual has an opportunity to assert himself.

"At the abrupt end of Doughty's 'Arabia Deserta' he tells of the injunction which the Sherif of the Hejaz sent to all the tribes and villages of his dominion:

'That in future, if there should arrive any stranger among them, they are to send him safely to the Sherif'; 'for who knows,' Doughty adds, 'if some European may not be found another time passing that way.'

"Many others have since passed that way, notably that wandering scholar, D. G. Hogarth, whom I had the great privilege to meet out on the edge of that land and who, to the world's infinite loss, has recently died; and his pupil, the enigmatical Colonel Lawrence, whom I also encountered during the war in the city from which Doughty set out; and then this great traveler and scholar, Dr. Musil, upon whom I now have the honor to confer the Charles P. Daly Medal in recognition of his contribution through travel and research to the body of geographical knowledge."

In accepting the medal Professor Musil said:

"A sailboat on a stormy sea; a helmsman using all his mental and bodily strength to bring his boat with its load to a sure harbor. How it reminds me of the sand storms in the desert and of my own strain and struggle to save my life and the results of my investigations; investigations that should be made accessible to any who are interested in the growth of our civilization.

"How grateful am I to Allah who brought me to the American Geographical Society and moved its Council to publish my works. Nobody in the world would have taken better care of these my children than the editor, Dr. Wright.

"Dr. Finley, I thank you for the Daly Medal and congratulate you upon being the President of the American Geographical Society."

Professor Musil then delivered an illustrated address on "Desert Life in Northern Arabia," in which, besides describing something of the daily life of the Bedouins, and picturing their geographic environment, he interpreted the spiritual reaction of the nomad to the desert scene.

Elections to Fellowship. At the December, January, and February meetings o the Society, President Finley presiding, there were presented with the approva of the Council the names of 146 candidates, who were duly elected as Fellows o the Society.

Annual Report of the Council

New York, January 24, 1928

To the Fellows of the Society:

To contribute to the advancement of geographical knowledge in all of its far-reaching relations is the Society's aim in its periodical publication, the *Geographical Review*. A reference to some of the more important material published therein during 1927 will indicate how this policy has been maintained.

The North American field is well represented in a variety of topics, ranging from problems of today, exemplified by the paper of Mr. Philip W. Henry, on "The Great Lakes-St. Lawrence Waterway," and of Dr. R. M. Brown, on "The Utilization of the Colorado River," to problems of historical geography such as Dr. Halldór Hermannsson's investigation into the question of the Wineland Voyages; while the two meet in Sir Patrick McGrath's account of "The Labrador Boundary Decision."

Two outstanding illustrated papers in the South American field are by Mr. Holstein on "Chan-Chan: Capital of the Great Chimu," one of the great cities of the western hemisphere of pre-Columbian times, and by Mr. Rudolph on the "Rio Loa of Northern Chile," a comprehensive survey of the chief river basin of the Atacama Desert. Also notable for its well-selected illustrations and for unusual picturesqueness of theme and treatment is Miss Semple's study of "The Templed Promontories of the Ancient Mediterranean." An intimate account of anciently preserved folk customs and characteristics in Hungary by the Rev. E. D. Beynon makes contrast with the theme of "Southern Rhodesia: A White Man's Country," by Mrs. Tawse-Jollie, member of the legislature of that newly constituted self-governing colony, or of Dr. Dixey's "Mlanje Mountains of Nyasaland," a description of physical aspects and economic prospects, by the government geologist of that protectorate.

In "Northern Arabia: The Explorations of Alois Musil" Dr. J. K. Wright, librarian of the Society and editor of its series *Oriental Explorations and Studies* summarizes and illustrates the great geographical contributions made by Professor Musil in thirty years of research.

The first year's field work of the Greenland Expedition of the University of Michigan described by Professor Hobbs makes an important contribution to our knowledge of the physiography and climatology of western Greenland. The opposite shore of the great island is the subject of a narrative, "The Colonization of Eastern Greenland: Eskimo Settlements on Scoresby Sound" by the Danish explorer, Ejnar Mikkelsen, a moving spirit in the enterprise. In "Interior Basin Drainage" Professor De Martonne gives the results of many years' work on a problem of fundamental importance in physical geography. Under the epigrammatic title of "World Unity" Professor Chisholm expounds his geographical philosophy.

Altogether the *Geographical Review* in 1927 included 39 leading articles, 73 items of geographical record, and 75 reviews. In addition to the many text maps and diagrams there were two insert maps in color and one in black and white.

Among the books and maps in course of publication by the Society during 1927 may be mentioned the following:

1. Problems of Polar Research, by thirty-one authors.

This book is a coöperative undertaking written by thirty-one of the leading authorities on polar problems. It is helpful to the layman and the scientist alike in that it informs the layman of the underlying purpose of polar exploration and assists the scientist by making available to him the plans and ideas of experts for the benefit of future exploration.

2. The Geography of the Polar Regions, by Otto Nordenskjöld and Ludwig Mecking.

This is a companion book to Problems of Polar Research. It constitutes the most complete regional reference book in English in polar geography.

These two books on polar research were produced in an effort to center attention upon the major problems remaining to be solved by further field study, to discover where and by what means it may best be attacked, and to suggest the form of coöperation between the sciences most concerned that would yield the largest harvest of results. The Society is deeply indebted to the thirty-three authors concerned for their willingness to join in making a fresh examination of the unsolved problems that inspire modern polar exploration. It is hoped that increasing support for well qualified expeditions may be one result of the publication of this comprehensive group of distinguished papers.

3. THE CORAL REEF PROBLEM, by William Morris Davis.

This volume contains the results of the author's original field studies extending over a period of ten years together with a review of the work of scientists who have interested themselves in the problem for nearly a century. It is a worthy successor to Darwin's classic study of coral reefs and demonstrates the essential soundness of Darwin's conclusions.

4. THE LAST GLACIATION, WITH SPECIAL REFERENCE TO THE ICE RETREAT IN NORTHEASTERN NORTH AMERICA, by Ernst Antevs.

A world survey of Pleistocene glaciation with a detailed study of the clay layers in the Hudson and Connecticut Valleys and Canada in continuation of THE RECESSION OF THE LAST ICE SHEET IN NEW ENGLAND, by the same author, published by the Society in 1922.

5. PRACTICAL HINTS TO SCIENTIFIC TRAVELLERS, Vol. 5.

This volume, the fifth in the series which is being published at The Hague by Professor H. A. Brouwer, contains articles by authorities on Ecuador, Eastern Congo, North Manchuria and the Russian Far East, and the Malay Peninsula.

6. ARABIA DESERTA, by Alois Musil.

In the report for 1926 attention was called to the publication of the first of a series of six volumes on Arabian geography and history prepared by Professor Alois Musil. During 1927 the second volume, entitled ARABIA DESERTA, was published. At the close of the year the third volume was in the hands of the binder. Publication of the entire series will be completed by the end of 1928.

7. THE LEARDO MAP OF THE WORLD, 1452.

The Society is publishing a full-size colored reproduction of the world map of Giovanni Leardo (1452 or 1453), the original of which was acquired in 1906. The reproduction is accompanied by an illustrated descriptive book of 89 pages.

8. BIBLIOGRAPHIE GÉOGRAPHIQUE.

The Society has continued its coöperation with the Association de Géographes Français in the publication of the BIBLIOGRAPHIE GÉOGRAPHIQUE, a fundamental international geographical bibliography. To the number for 1925 the Society's staff contributed about 350 bibliographical references and 125 brief reviews.

9. A map of NORTHERN ARABIA on a scale of 1:1,000,000, based on Professor Musil's original surveys, was published during the year. This map, which illustrates the second, third, fourth, and fifth volumes of Professor Musil's work, is printed in black and brown in four sheets.

10. In the *Geographical Review* the following insert maps have been published: a map of Interior Basin Drainage, by E. de Martonne and L. Aufrère, to accompany Professor de Martonne's article on the subject; a map of Scranton, Pa., showing land utilization, to accompany an article by Clifford M. Zierer on Scranton as an urban community; map of Lyme, N. H., in 1830, 1860, 1892, 1925, to accompany the article by J. Walter Goldthwait entitled "A Town That Has Gone Downhill."

11. Millionth Map of Hispanic America.

The final printing of several of the twenty sheets of this map which were announced in the last annual report has been greatly delayed by a strike at the firm which is lithographing and printing the map. The last of the sheets are now being printed, however, and will be ready for distribution by the end of January.

Good progress has been made during the year in the assembling of source material and the compilation and fairdrawing of additional sheets. Fairdrawing has been completed on ten sheets, and the fairdrawing of four others is in progress. Compilation has been completed on six others, and eight more are in process of compilation. The coöperation of the many institutions and companies who have contributed to the Society's collection of source material for the map has continued, and a large number of important surveys has been added to the collection. Several of the Hispanic American governments have shown their interest in the map by contributions of important surveys, the greater part of which are unpublished. This has been particularly notable in the case of the government of Ecuador, which has sent to the Society the entire collection of original surveys from the archives of the Department of Public Works. The collection was sent in charge of Colonel Luis T. Paz y Miño, Sub-Secretary of War and noted Ecuadorean explorer and cartographer, who has been commissioned by his government to assist in the compilation of the Ecuadorean sheets of the map.

Field Expeditions

The Society is able occasionally to lend instruments to well-qualified expeditions and to provide specially prepared maps and tables for the use of field parties. More direct encouragement has been given during the year under review to four expeditions engaging in exploration of high geographical promise. The Putnam Baffin Island Expedition, whose geographical work was done under the auspices of the Society, left New York in June and returned in October. In the short open season of the Foxe Basin several lines of sounding were made as far north as the entrance to Fury and Hecla Strait, the basin being navigated for the first time in a hundred years; and the coast line of northern Foxe Land was charted for the first time, giving a part of the western coast of Baffin Island an entirely new position. Mr. George Palmer Putnam, director of the expedition, deserves high praise for his businesslike organization and conduct of the whole expedition. A report on the results of the expedition was published in the *Geographical Review* for January, 1928.

In continuation of his program for several years' exploration in the Arctic basin, Captain George H. Wilkins secured additional equipment early in the year and in March made a flight of 550 miles due northwest of Point Barrow, alighting on the ice safely. His position was longitude 175° W., latitude 77°45′ N., or almost midway between the tracks of the *Jeannette* and the *Norge*. With an echo depth finder provided by the Society he was able to make a sounding, obtaining as a result 5440 meters, the greatest depth so far discovered in the Arctic basin. On the return a second and eventually a third landing was made on the ice, Captain Wilkins and his pilot, Ben Eilson, returning on foot to Point Barrow after the exhaustion of the fuel supply. In 1928 Captain Wilkins proposes to fly northeast of Point Barrow, if possible to the site of "Crocker Land."

In pursuance of the policy of the Society to add to its collection of original surveys for compilation in the Millionth Map of Hispanic America by conducting surveys of its own in critical areas, a party was sent to Peru in June under the leadership of Mr. O. M. Miller, of the Society's School of Surveying, to make a topographic survey of the headwaters of the Marañon River and to carry out a number of traverses in the montaña between the Marañon and Huallaga Rivers in order to tie together a number of earlier surveys by various explorers. Mr. Miller's last report stated that the surveys at the headwaters of the Marañon had been completed and that the work in the montaña was under way. The government of Peru has shown great interest in the plans of the expedition and has supplied a military escort and otherwise greatly facilitated the work.

In September Mr. and Mrs. Joseph H. Sinclair left for Ecuador to carry out a program of surveys and geographical and geological studies in the Oriente region of Ecuador under the auspices of the Society. They will continue the survey work begun by Mr. Sinclair and Mr. Theron Wasson in 1921. The special objective of the expedition is Mt. Sumaco, a volcano which was located by the expedition of 1921 and which the present expedition proposes to study and map. The surveys made by this expedition will be a very important contribution to the source material for the Map of Hispanic America since they will cover one of the least-known regions in South America.

The School of Surveying

During the year many people have consulted the School for technical information on surveying and astronomical subjects, especially in the field of aerial survey. Six field expeditions were lent instruments and provided with various charts and accessories. The School library has been organized and indexed, and an international survey periodical service has been established.

New instruments added to the School's equipment during the past year include three wireless sets, a barograph, and two plane tables of aluminum designed for portability. The Radio Broadcast Laboratory of Garden City has coöperated with the School in the design and production of field wireless time-signal reception apparatus with the result that there have been in use during the year two sets weighing only twenty-three pounds, including batteries, and yet capable of receiving anywhere in the world one or more time signals of the order of excellence of Arlington, Rugby, Eiffel Tower, Nauen, Honolulu, or Saigon. If the governments of the world could agree to send scientifically accurate time signals on wave lengths of the order of thirty to forty meters an exploration time-signal set could be made to weigh less than six pounds with corresponding simplification of design.

The computation of star time-tables in connection with the equal altitude method has progressed rapidly. The object of these lists is to obviate the necessity of computing a star program in the field.

In April, Mr. Weld Arnold went to Guatemala in connection with the boundary work of that country, but the beginning of the rainy season and a change in the personnel of the government brought about his return in July. Mr. Miller's work in Peru is described in an earlier paragraph.

Population Studies in the United States

The Society is now enabled to begin a series of specialized studies upon the population of the United States. These will be made region by region, New England being the first field of investigation in view of the highly critical state of its agricultural and part of its industrial population. From the related subjects of economics and sociology contributions will be sought to make a well-rounded study of the history of settlement with a view to furnishing an essential background for the conditions of today. It will be understood that population studies in the United States are necessarily coöperative, for many types of investigation are needed to reflect the nature of our diversified country.

The Scientific Study of Settlement

Excellent progress has been made in the study of pioneer belts during the past year. This project, originally presented to the National Research Council in 1925, was endorsed by that organization and recommended to the Social Science Research Council. A committee of each council gave the subject a thorough examination, and eventually support was obtained to provide for a study of wide scope. As a beginning a book by twenty-five or thirty authors will be prepared, similar to the volumes on polar research in wideness of scope, with emphasis on problems of immediate concern in the settlement of undeveloped lands.

The Canadian government and a committee of Canadian scientists have cordially joined with a committee of the Social Science Research Council in outlining (and eventually in administering) a program of study adapted to Canadian conditions. A part of the intensive study now in process of organization will relate to marginal lands in the United States. At a later time the coöperation of governments and institutions most concerned will be sought to advance similar studies in the remaining pioneer lands of first importance. Two papers outlining the problem are: "The Scientific Study of Settlement" (*Geogr. Rev.*, Oct., 1926) and "The Pioneer Fringe" (*Foreign Affairs*, Oct., 1927), the latter illustrated with a first tentative world map of pioneer regions.

Distribution of Publications to Graduate Students

To encourage graduate students in geography in the various universities of the United States the Society distributed during 1927 sixty sets of books and periodicals published by the Society in recent years. The students selected were those recommended by the geographical departments of the leading universities and colleges, and for the most part included men and women who are entering geography as a profession. The responses have been most encouraging.

Library Organization

Additions to the library during the year comprise 966 books, 415 pamphlets, 9706 new issues of periodicals, 1893 maps, and 62 atlases.

The library has continued its activity in accordance with the principles explained in the report for 1926. Cards representing over 2000 books, pamphlets, periodical articles, and maps were entered in the special research catalogue. A survey of missing volumes in the files of publications of geographical societies has been made, and the library is endeavoring to fill the gaps.

During the year the library coöperated with the New York Public Library in compiling a list of maps of New York. It also coöperated in the publication of the Union List of Periodicals and the Bibliographie Géographique. An author index to the research catalogue was completed, and a list of geographers in the United States compiled.

The Lecture Program

The speakers and titles upon the Society's lecture program during the past year are as follows:

H.R.H. Prince William of Sweden, "Exploration in the Land of the Pygmies"; Dr. John C. Merriam, "Cave Exploration and the Antiquity of Man"; Professor William H. Hobbs, "The First Greenland Expedition of the University of Michigan"; Sir Curtis Lampson, "Across the French Sudan to Timbuctu"; Dr. Samuel K. Lothrop, "Aboriginal American Culture and the Geographical Environment"; George Palmer Putnam, "Exploration in Baffin Island"; James L. Clark, "Across the Snows and Deserts of Asia."

Medal Award

The Charles P. Daly Gold Medal of the Society was awarded to Professor Alois Musil of the Charles University, Prague, in recognition of his distinguished explorations in and scholarly books on Arabia. Presentation of the medal will be made at the February meeting of the Society.

The number of Fellows at the close of the year was 5195, of whom 398 are Life Fellows. In addition there are 5 Honorary Members and 35 Corresponding Members.

The report of the Treasurer submitted herewith gives a condensed balance sheet and a summary of the income and expenses of the Society.

PHILIP W. HENRY
Chairman

REPORT OF THE TREASURER FOR 1927

RECEIPTS AND EXPENSES

During the year there have been received from annual dues, interest on investments, and sales of publications	$77,312.28
There have been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	94,451.83
Balance charged against Special Deposit Fund	$17,139.55

CONDENSED BALANCE SHEET, DECEMBER 31, 1927

Cash	$13,554.51
Sundry balances and investments	87,152.49
Inventory of publications	8,607.14
	$109,314.14
Capital Account, Balance uninvested	4,322.20
Annual dues paid in advance	5,058.56
Special Fund for general purposes	33,150.94
Sundry deposits and reserves	35,801.08
Millionth Map Publication Fund, Balance	30,981.36
	$109,314.14

REPORT OF THE SPECIAL COMMITTEE

New York, January 19, 1928

The Committee appointed at the meeting of the Council held on December 15, 1927, to nominate officers for the vacancies to occur in the Council in January, 1928, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 24, 1928:

		Term to expire in
President	John H. Finley	January, 1929
Vice-President	James B. Ford	January, 1931
Recording Secretary	Hamilton Fish Kean	January, 1931
Foreign Cor. Secretary	Frederic C. Walcott	January, 1930
Treasurer	Henry Parish	January, 1929
Councilors	Philip A. Carroll Archer M. Huntington	January, 1931

John Greenough
W. Redmond Cross } *Committee*
Paul Tuckerman

GEOGRAPHICAL RECORD

NORTH AMERICA

The Winter Maintenance of Highway Transportation. The last two decades have seen a great revival of highway transportation so largely superseded by canals and railroads in the last century. The passenger automobile and the motor truck are revolutionizing living conditions in both town and country. The rapidity of the movement is graphically shown in the road surveys recently issued by various states. Take for instance the "Report of a Survey of Transportation on the State Highway System of Ohio" by the Bureau of Public Roads, U. S. Department of Agriculture, and the Ohio Department of Highways and Public Works (1927). From it we learn that the State Highway Department spent $460 on roads in 1905 and $17,000,000 in 1926 and a total of over $95,000,000 in the 22-year period. During this time almost as much was expended by the counties, and a substantial sum was received from Federal aid. In 1925 Ohio had approximately 85,000 miles of rural highway, of which 13 per cent constituted the state highway system. The motor vehicle movement was estimated at three and three-quarter billion vehicle miles, of which more than half was carried by the state highways. In 1913 Ohio had 59 persons to a car; in 1925 less than 5. Among the several maps accompanying the report one on a scale of 12 miles to the inch, showing the volume of traffic along the highways and the distribution of population, affords a striking illustration of the close relation between urban development and highway traffic.

The vast outlay upon highways and the dependence placed upon them—by mail, school, and medical services, for instance, as well as the ordinary goods and passenger traffic—demand continuation in use. The greater part of the United States, however, is faced with the problem of suspension of road circulation for a longer or shorter time during the winter months. How the problem is being met is told in the Snow Removal Reports of the Bureau of Public Roads, digests of data furnished by state officials for the "thirty-six snowfall states." The report for the winter of 1925–1926 is an interesting document which, in addition to statements on progress of the work, gives some discussion of the general problem. A map of the United States on a scale of 100 miles to the inch shows the roads kept open for winter traffic in the regions of heavy snowfall and also the depth of snowfall by contours from the Atlas of American Agriculture; a separate map shows the average annual number of days with snow cover from the same source. In general the snowfall states have over 10 inches of snowfall and over 10 days duration of snow cover. Apart from the mountainous West the areas of heaviest snowfall are the Michigan peninsulas and the northern parts of New York and the New England states, with over 60 inches. Likewise these areas, with a westward extension through North Dakota, have a snow cover of over 90 days' duration. The chief difficulty in snow removal is caused by drifting, for snow rarely falls to a depth exceeding 9 inches in individual storms in the non-mountainous areas. The problem is worse in the colder regions, where the snow is dry and drifts more readily. Much can be done in the way of prevention; for instance, by the removal of hedges or tight fences so disposed along the roads as to cause drifts. Artificial protection is afforded by the construction of snow fences placed suitably in relation to the wind. The state of Michigan is acquiring rights of way 400 feet wide through wooded land, trees and brush being left to act as drift preventives.

The rapid progress in snow removal on state roads may be seen from the tables accompanying the report for 1926–1927. In the winter of 1922–1923 the mileage of roads from which snow was removed was 27,000; in 1926–1927 it had increased fourfold: the equipment of truck plows and tractor plows, 405 in 1922–1923, was increased to 3896 in the same time.

Mt. Multnomah, a Cone-Filled Caldera of the Cascade Range. Crater Lake, occupying a great caldera formed by the engulfment of the hypothetical cone of Mt. Mazama on the dissected highlands of the Cascade range in southern Oregon, is already famous. A still greater, yet less known caldera, once occupied by a larger lake but now in part filled by cones of later eruption, represents another hypothetical cone, presumably 15,000 feet high in its prime and measuring over 50 miles along the radius of its lava flows, for which the name of Mt. Multnomah has been proposed and of which an admirable description has been prepared by E. T. Hodge, professor of economic geology in the University of Oregon (Mount Multnomah: Ancient Ancestor of the Three Sisters, University of Oregon, Eugene, Ore., 1925). Its remains crown the highlands of the Cascade Mountains at an altitude of 5000 feet, about midway between the northern and southern borders of Oregon. The highlands, which have a breadth of 75 miles, descend to the east with a gradual and moderately dissected slope; but to the west, where the rainfall is greater, their more rapid descent is diversified by deep-cut valleys. The crest line between the two descents is known as the "break" of the range and is followed by the Skyline trail southward from Multnomah for 250 miles past many other superposed and more or less dissected volcanic cones.

The great Multnomah caldera, admirably shown in a generalized diagram, now rises in a number of crests with in-looking cliffs, of which North Sister, Little Brother, Husband, Wife, and several other members of the gigantic family are the chief summits. The other two of the Three Sisters are later-formed, caldera cones, from which lava streams have flowed down through erosional gaps in the caldera rim. The higher mountains have been rather strongly glaciated, as shown in Figure 24; some of them bear diminished glaciers today. Recent lava flows, some of them cascading down cliffs, others collapsing in doubled ridges, are well generalized in Figure 26.

The later pages of this most attractive essay contain sections on springs, lakes, streams, flora, and fauna. The only ground for adverse criticism is found in the statement that the Glacial period here was closed by a sinking of the Oregon fault block: this is questionable, because most regions from which Quaternary glaciers have disappeared give no sufficient evidence of having sunk enough to melt their ice streams. On the other hand, the essay as a whole is exceptionally intelligible, partly because of its well reasoned explanations and its well ordered presentation, partly because of the unusual excellence of its many illustrations. The region described must be of superb scenic attractions.

W. M. Davis

A Soil Map of Florida. The Seventeenth Annual Report of the Florida State Geological Survey (Tallahassee, 1926) contains a generalized soil map of the state by Roland M. Harper. The map is on a scale of 1:1,000,000 and shows 11 soil types, briefly characterized in the legend, described more fully in an accompanying text. The amount of swamp land in the state is not so large as is commonly thought. About two-fifths of Florida is rolling or hilly upland with very little swamp; of the remainder—flatwoods, muck, marl, and other level areas—about one-fifth is perpetually saturated or subject to inundation. About 80 per cent of the soils may be described as sand. The fertility is generally low, the average being probably less than in any other state in the Union. Cultivated or improved land formed only 2 per cent of the total area in 1880, and 6.5 per cent in 1920, and did not increase in the next pentad; although, according to the State Census for 1925, there was a corresponding increase in population of 30 per cent. However, in Florida soil fertility is not an index to farm value. Through the extensive use of fertilizer, the selection of crops, and general superiority of methods the value of farms in central and southern Florida, with its poorer soils, greatly exceeds that of the more fertile north (see R. M. Harper: Agricultural Conditions in Florida in 1925, *Econ. Geogr.*, Vol. 3, 1927, pp. 340–353). The average for the state is above the average for the country as a whole and so is the value of crops per acre.

SOUTH AMERICA

The Economic Status of British Guiana and Its Improvement. The economic history and present status of British Guiana are succinctly presented in the following table from the Report of the British Guiana Commission, 1927 (Cmd. 2841).

	Population	Exported Sugar Tons	Value of Sugar and By-Products Exported £	Total Value of All Exports £	Percentage of Sugar, Etc., to All Exports
1836	98,000	59,000	1,847,786	2,135,379	84
1925	304,000	97,000	1,551,745	2,967,096	53

The Report goes on to say: "For the appreciation of the full implications of these figures it is necessary to add that the increase in population was entirely due to assisted immigration of labour for the plantations and not to any natural increment; that throughout this period the area under sugar has steadily declined; that the whole rise in sugar exports shown had been achieved over forty years ago since when production has remained stationary with a tendency to diminish; and that the relatively smaller proportion of sugar exports to total trade is almost entirely due to a sudden rise in the output of alluvial diamonds which cannot be regarded as a stable or permanent factor in the economy of the Colony."

While natural obstacles are held responsible in the main for the condition of stagnation, other causes have been contributory, not the least of which is the political constitution, an heritage from Dutch colonial days. Amends in this respect are likely to follow the recently issued report of a local commission as a White Paper.

The recommendations of the Parliamentary Commission include the diversification of agriculture in the alluvial belt, the introduction of the groundnut being specially urged. The remarkably successful cultivation of this crop in Nigeria is instanced. The export of groundnuts from Nigeria is at present exceeded in value only by that of palm oil and kernels, and this though the bulk of the crop comes from the Kano region, 700 miles from the seaboard. At present only 140,000 out of 3,500,000 acres of the coast belt of British Guiana are under cultivation. Drainage and irrigation works, already begun, should be continued under government control. The crying need of population remains. The Commission suggests that the overpopulated islands of the West Indies, notably Barbados (940 per square mile) and Jamaica, should be looked to as a source in preference to India, until 1917 for many years the major source of immigration into British Guiana. The terms recently proposed by the government of India for resumption of the East Indian immigration would involve heavy expenditure on the part of the colony.

The alluvial belt occupies six per cent of the total area of the colony; a somewhat larger area of the interior is open country; the rest, 87 per cent, is forest-covered. A few years ago a Forest Department was created, and systematic investigation of the colony's great timber resources began. In 1926 the Department explored, mapped, and evaluated an area of some 650 square miles between the Essequibo and Mazaruni Rivers. The outstanding feature of the area is "the greenheart forests which were found over the best compact self-contained area of 70 square miles to compose 31 per cent of the total crop, a most unusual density in a virgin tropical forest."

The Department is now turning its attention to the North-West District, "nearly 10,000 square miles of undeveloped country, mostly under primary forest and occupied by a population of 11,000 persons, half of whom are aborigines." In this connection it is noted that the aborigines have been of much service to the investigators and that they make excellent woodsmen. For mutual benefit it is suggested that care of the natives be transferred to the Conservator of Forests.

Today the only large contribution to the export trade from the interior is made by diamonds (28 per cent), although good progress has been made in the production of bauxite (6 per cent) since the industry was started in 1916. The proved diamond field of some 1200 square miles in the middle portion of the Mazaruni basin has been the subject of a recent government survey, whose prime object was determination as to whether the diamond and other mineral resources of the alluvial deposits would justify construction of a railroad to the fields (H. J. C. Conolly: Report of the Preliminary Survey of the Mazaruni and Puruni Diamond Fields, British Guiana, March–December, 1925, Part I). The conclusions are not favorable to a project based on mineral prospects alone. There are many advocates of railway building as a means of opening up the interior. A proposed route, now under investigation, would run from Bartica or some point on the Essequibo in reach of ocean-going steamers to the Tiboku Fall whence safe navigation on the Upper Mazaruni begins. But, as the Commission points out, a railroad will not of itself bring about the development of the colony; and the failure of the interior railroad of Surinam, 150 miles long, is cited.

Snowstorms in the Central Valley of Chile. In a region where snow seldom occurs more than once in a lifetime its almost annual recurrence in the last few years challenges explanation. History records but eight snowstorms in the Central Valley of Chile between the founding of the colony and 1920, occurring in 1536, 1647, 1832, 1848, 1853, 1891, 1898, and 1912. From 1920 to 1924 it snowed each year; and on September 7, 1927, a sixth snowfall occurred, lasting five hours. The phenomenon is discussed by Julio Bustus Navarrete in the September, 1927, issue of the *Boletin del Observatorio del Salto* (Santiago).

Navarrete locates the snowstorms in the latter half of a period of low pressure and immediately following the line along which the wind shifts from north to south or south-east. A further wind shift back to a northerly direction dispels the cold wave and wipes out all traces of snow. Beyond this point Navarrete accepts and utilizes the theory, and occasionally the exact words, of his predecessor, Benjamín Vicuña Mackenna in "Ensayo historico sobre el clima de Chile," published in 1877. Both authors correlate years of drought with years in which snowfalls occur. Records indicate such correlation in 1647, 1832, 1847, and 1853. Such definitely was the case in 1924. The exaggerated accounts of the length of the snowstorms lasting "ninety-nine hours," "one hundred and eleven hours," and "three days continuously" indicate the traditional quality of the early reports. No snowstorm of the last decade has lasted more than nine hours. No reliable meteorological information exists before about 1860. Records since then in no way substantiate the theory relating snowstorms to periods of drought. Were this theory correct we might have expected snowstorms to follow the unusually dry years of 1869, 1886, and 1892. Conversely, we should have expected none in 1920 since the precipitation in 1919 was nearly double the normal. The concurrence of snow and drought in 1924 seems to have been the exception rather than the rule.

EUROPE

The Present Situation and Trends of the Mineral Industry in Upper Silesia. Before the war the Upper Silesian industrial area was one of the most important in Germany. With regard to coal and iron Bohemia and Poland in 1913 were competitors rather than customers, hence Upper Silesia sought and found her markets in the Fatherland. Raw materials came from the north and west, and the markets were located in those directions. The network of local railways and canals uniting the area and the direction of the natural routes helped Upper Silesia to turn its back on its neighbors to the south and east.

Before the war it was in the Industrial Triangle, less than 20 miles in length and about 15 miles in width, that nearly half the population of Upper Silesia was found. Four-fifths of the coal, all of the zinc produced, and nearly all of the metallurgical plants were located in this small area. The new boundary cut the Triangle in two, the larger part being assigned to Poland. The change was obviously a great blow to industry here, in spite of the fact that the League of Nations prescribed certain temporary measures to lessen the shock. Looking back after six years the economic changes can be seen in better perspective, and the results can be more clearly understood than immediately after the partition.

TABLE I—BITUMINOUS COAL OF GERMAN UPPER SILESIA AND PERCENTAGE OF TOTAL GERMAN PRODUCTION

YEAR	PRODUCTION	PERCENTAGE
*1913	11,090,908 metric tons	8
1923	8,744,679 " "	13
1924	10,900,259 " "	9
1925	14,272,687 " "	10
†1926	17,461,659 " "	

* Total German production was 43,170,000 tons of which Upper Silesia produced 23 per cent.
† This figure from *Vierteljahrshefte zur Statistik des Deutschen Reichs*, Vol. 36, No. 3, 1927.

The coal production of German Upper Silesia in recent years is shown in Table I (*Mineral Industry*, Vol. 34, 1925, p. 167, and Vol. 35, 1926, p. 140), the figures referring only to the territory on the German side of the frontier. Two factors have contributed to the increased output: the respite from the duty-free importation of Polish coal, which ended in June, 1925, and the introduction of mechanical improvements in the mining equipment. This latter is well illustrated by the fact that in 1913 there were 420 horses in use, while in 1925 there were only 127. In 1925 there were over seven times as many electric hand drills in use as there were in 1913. These are only two instances of the many, cited in the League of Nations Memorandum on Coal (Vol. 2, May, 1927), which show the transition from manual to machine labor in German Upper Silesia.

The largest reserves of coking coal, of which the supplies are meager, are in the county of Zabrze, and most of the mines here have remained with Germany. On the other hand, much of the coal now being mined at Rybnik is capable of producing coke superior in quality to that of Zabrze, and these Rybnik mines have all been allotted to Poland (for a map see Bruno Dietrich: Oberschlesien, seine Stellung innerhalb der deutschen Ostmark und seine Grenzen, *Verhandl. Deutschen Geographentage*, Vol. 21, Berlin, 1926, pp. 97–112, reference on p. 115; and see P. Dumas: Le partage de la Haute Silésie, *Ann. de Géogr.*, Vol. 31, 1922, pp. 1–14). Germany's loss in this respect is not serious as there are large supplies of coking coal in the Ruhr district. On the other hand Poland gains an important advantage, since the mines of former Polish territory produce no coking coal. The total quantity of coke produced in all Upper Silesia before the war amounted to two million tons annually, most of which was used in local industries. The total output of coal in Polish Upper Silesia in 1925 amounted to 23,433,630 tons.

Table II shows the export of coal from German Upper Silesia for three years (1923–1925) succeeding the partition of the coal basin with Poland (*Commerce Repts.*, July 5, 1926, p. 40).

TABLE II—EXPORT OF COAL PRODUCED IN GERMAN UPPER SILESIA

(*In metric tons*)

COUNTRY	1923	1924	1925
Poland	60,326	52,979	66,087
Czechoslovakia	17	129,838	553,564
Austria		57,081	121,104
Hungary		16,396	20,488
Other countries		9,166	18,157
Total	60,343	265,460	779,400

In competition with the other coal fields of Germany, Upper Silesia works at a distinct disadvantage. There is first the competition of the Lower Silesian and Saxony fields; farther afield but most important of all domestic competitors is the Ruhr mining region, whose proximity to the entire region west of the Elbe gives it the advantage over Upper Silesia. From the northwest comes a formidable rival in the shape of British coal, as cheap transportation allows this to compete with Westphalian and Upper Silesian coal in the Berlin markets and the North Sea ports.

With these difficulties to meet in the north, it seems likely that expansion of the Upper Silesian coal trade will tend towards the foreign markets to the south and east rather than to the home markets of the northern plain.

Before the war German control of the international zinc market was strong. The German Zinc Syndicate controlled one-half of the world output of zinc and three-quarters of the European production. Next to Belgium, Germany was the greatest exporter of zinc in 1913. In that year Upper Silesia supplied 60 per cent of the German production. Figure 1 shows the output of the chief zinc-producing countries of Europe: (a) before the boundary changes of 1921, and (b) after the territory containing the greater part of the Upper Silesian zinc and lead deposits had been assigned to Poland.

The zinc industry of Polish Upper Silesia made satisfactory progress until about the middle of 1925. The heavy export assessments after that date practically suppressed the industry, as all metals and ores had been passing througn Germany and were reduced by German operators. The mine owners on either side of the boundary line were seeking control of the mineral and metal industries. It was a chaotic condition that American interests faced in the fall of 1925 when an option was taken of all the mines, manufacturing plants, etc., of the Giesche Heirs Incorporated, located on both sides of the boundary line. In the settlement of the controversy, as it emerges in 1927, neither German nor Polish control exists in Poland. All mining interests are now possessed by American, Czechoslovakian, British, Belgian, and French capital.

The Giesche holdings taken over by the Harriman Company of New York and the Anaconda Company of Montana comprise zinc mines, smelters, and coal mines.

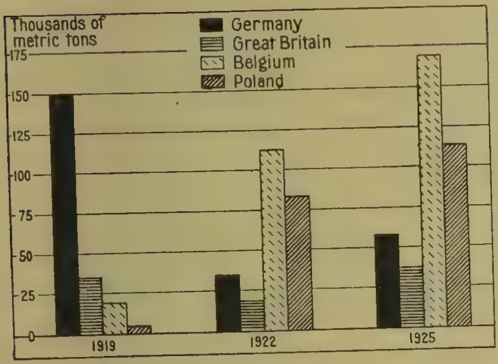

FIG. 1

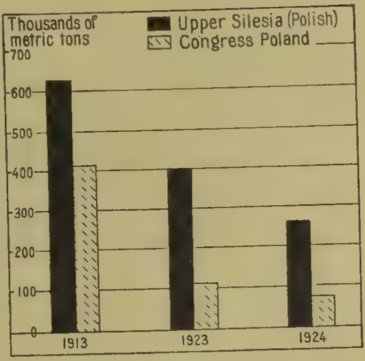

FIG. 2

FIG. 1—Output of the chief zinc-producing countries of Europe. Data from *Mineral Industry*, Vol. 34, 1925, p. 746.

FIG. 2—Pig iron production in Polish Upper Silesia (territory ceded by Germany in 1921) and Congress Poland. Data from *Mineral Industry*, Vol. 34, 1925, p. 419.

The acquisition of these mines, one of the largest bodies of high grade zinc ore in the world, together with the American mines already owned will give Anaconda control of between 16 and 17 per cent of the world's zinc production (*Engineering and Mining Journ.*, Vol. 120, 1925, pp. 781–782). The output of zinc ore in Polish Silesia increased from 268,775 metric tons in 1925 to 337,423 tons in 1926 (*Annuaire Statistique de la République Polonaise*, Vol. 4, 1925–1926 and Vol. 5, Warsaw, 1927), an indication that the American transactions are already having favorable results.

The iron ore deposits of Upper Silesia are less important than those of coal or zinc; but in 1910, 901,366 tons of pig iron (9 per cent of the German output) were produced here. In any attempt to account for the recent changes in the output of iron and steel in German Upper Silesia it must be realized that 97 per cent of the iron ore deposits of this area went to Poland in 1921.

The trend of production of pig iron in recent years in Polish Upper Silesia (which was German territory previous to 1921) and Congress Poland are shown in Figure 2. One reason for the decrease in output is that the ore supplies are giving out. The provisioning of the blast furnaces is largely composed of foreign metal, mostly Swedish. Before the partition of 1921 Upper Silesia produced chiefly heavy forms of steel, such as rails, structural steel, and pipes, which were marketed in southern Germany. With the continued decline in the ore output manufactures of this kind can hardly survive. Those works which specialize in more valuable steel products for the automobile and electrical industries, for German rather than for Polish markets, are the most active; and beyond doubt, if the industry is to continue, it must change to the manufacture of products requiring less raw material but greater skill in the making.

This last year (1926–1927) Poland's iron and steel industry has begun to feel the benefit of the general European revival and is having success in Eastern Europe in competition with Czechoslovakia. Exports have greatly increased as a result of closer relations with Austria, Hungary, Bulgaria, and Jugo-Slavia, while in Rumania, in particular, there has been a conquest over the Czechoslovakian product (*Mineral Industry*, Vol. 35, 1926, pp. 385–386).

E. MURIEL POGGI

Hydro-electric Industry and Labor Problems in the French Alps. In his latest contribution on the hydro-electric development in the French Alps Professor Raoul Blanchard notes some interesting changes in industrial distribution dependent on the problem of labor supply (The Utilization of Water Power in France, *Harvard*

Business Rev., Vol. 6, 1928, pp. 176–187). Silk weaving, at first concentrated in Lyons and after the beginning of the nineteenth century spreading out into the surrounding country, was originally a home industry. With the introduction of the power loom came the tendency to concentrate in larger and larger factories, employing up to 500 to 600 looms, the labor, chiefly women and girls, in some cases being brought from a distance and housed in dormitories. Today an interesting retrogression is being witnessed.

The war called the women to the land; and subsequent progress in agriculture has generally improved the status of the peasantry, who do not take kindly to the earlier conditions. The larger mills are being broken up into smaller factories employing from 10 to 25 looms, while there is a growing tendency to the installation of two or three looms in the home on which the family works when agricultural labors permit. The flexibility in the use of hydro-electric power and the well developed power-distribution net make this feasible.

In the earlier days of the industry before much advance had been made in power transmission the electro-chemical and electro-metallurgical industries were installed in the heart of the Alps, close to the power sources; and there most of them remain. The labor problem is met by importation of foreigners, chiefly Italians. In the Maurienne valley, for instance, 70 to 80 per cent of the workers come from Italy. A considerable percentage is seasonal. At least a quarter of the workers return for from three to five months during the winter season of low water and reduced power supply. In this industry too, however, the present tendency is to install new plants on the edges of the mountains, nearer transportation routes and a denser population

Natural Preserves and Natural Parks in Fenno-Scandia. We in the United States become so thoroughly absorbed in the development of our own domain that we are sometimes almost startled when we learn of a diminutive country's ambition to accomplish ends usually construed by us as more or less the exclusive privilege of large and affluent lands. However, the political divisions of Fenno-Scandia entertain no such ideas, as is indicated, for instance, in their national parks policy. While they conceive something of the utilitarian in these preserves by way of their likely attraction of tourists, a view no different from our own, yet pride in their country and enthusiasm for the preservation of natural plant and animal habitats has had no less influence.

Finland has surveyed ten areas, nine in the northern third of the country and one in the southeast corner northeast of Lake Ladoga, which it proposes to set aside as preserves or parks. Recommendations of the reconnaissance parties are not identical in each instance, hence the use of the terminology preserves and parks. In some cases a preserve is suggested because of the desirability of protecting certain species of plants or animals, while in other cases conservation of scenery is paramount, and plants and animals are to receive incidental protection.

The struggle of the scant population of northern Finland is recognized by provisions that, in times of crop failures, proposed restrictions may be temporarily waived in their behalf and that at all times certain hunting and fishing privileges be assigned to them, restricted only by seasonal influences upon the life or variations in rate of reproduction. In these regulations we observe a striking contrast with those applying to most of our own natural parks problems. The wealth of the United States does not necessitate laws modified in favor of a struggling population.

Two papers in the publication "Silva Fennica" of the Society of Forestry in Finland, No. 1, 1926, and No. 3, 1927, present interesting detailed scientific accounts of these regions, accompanied by photographs of characteristic scenes.

What has been noted about the natural park movement in Finland applies likewise to Norway, which proposes parks or preserves for parts of Spitsbergen. There animal life represents a large economic resource, and through the medium of regulation and preserves it is hoped that greater control of animals such as the walrus, polar bear, reindeer, and others can be effected. Problem and plans are given in detail in a bulletin entitled "Naturfredning i Norge," Årsberetning, 1926. An abstract of this paper appears in English in the *Norwegian Trade Review* (Vol. 10, 1927, No. 1, pp. 5–12), and it has been discussed by Dr. R. N. Rudmose Brown in a recent number of the *Scottish Geographical Magazine* (May, 1927).

Since 1909 Sweden has set aside 13 national parks of a total area of 3650 square kilometers and thus possesses the most important series of reservations in Europe. Setting aside of other areas is under consideration. The parks are distributed from the southern end of the country to the northern; and they thus represent practically all aspects of Swedish nature, though above all its harsh but magnificent subarctic and arctic phases, since all the large parks lie in Norrland, the largest within the Arctic Circle. An attractive booklet on the parks has been published by Dr. C. J. Anrick, secretary of the Swedish Touring Club, "Våra svenska nationalparker" (Stockholm, 1927).

EUGENE VAN CLEEF

AFRICA

The Port of Alexandria. Alexandria now occupies third place among Mediterranean ports. In the volume and value of goods handled it is surpassed only by Genoa and Marseilles. Its phenomenal development since the British occupation of Egypt in 1882 has been a response to the increasing prosperity and growing population of Egypt as a whole. A valuable study by Alessandro Breccia of the port of Alexandria was published last year in Italian as Volume 14 of the *Mémoires de la Société Royale de Géographie d'Égypte.* Breccia gives a historical sketch followed by chapters on the technical facilities of the port at the present time, on its commercial relations, on its defects, and on its needed improvements.

The present population of Egypt is about 13,800,000. It is estimated that when certain cultivable, but at present unused, lands in the lower Nile valley and especially in the delta have been reclaimed and occupied the population could be increased to 17,500,000. Furthermore, the maximum density of population which the Egyptian fields are capable of supporting has probably not yet been reached. In 1924 Prince Omar Tussun calculated that in thirty years a total population of about 21,000,000 might be looked for. The probable future increase, whether or not these figures are correct, will mean a corresponding expansion of the trade of Alexandria, a growth that will render extensive improvements in the harbor facilities absolutely imperative. Although the water surface for anchorage is greater at Alexandria than at either Genoa or Marseilles, the improved water front is too short and the railway facilities are inadequate and inconvenient along the quays and wharves. The most serious hindrance to normal growth lies in the present condition of the Mahmudieh Canal, Alexandria's main line of water communication with the Nile and thus with Cairo and the interior of the country as a whole. This canal, constructed by Mahomet Ali in 1819 and the following years, is now too narrow, too shallow, and too much encumbered with "parasite constructions and obstacles of all sorts" adequately to care for the full volume of traffic that should pass through it. It sometimes takes as much as five weeks for a loaded barge to travel the 130 odd miles from Alexandria to Cairo.

Those who have her interests at heart are troubled by the fact that Egypt is becoming a land of one crop. In 1925 the total value of Egyptian exports was £E 59,198,662, of which textile products (mainly cotton) amounted to £E 52,024,761. Egypt is subject to all the economic dangers that menace a region whose prosperity is based upon monoculture. One means of avoiding these dangers is the stimulating of industrial enterprises of all sorts. If present plans for the establishment of manufacturing on a considerable scale are ever brought to fruition, even greater demands will be placed on the port of Alexandria.

In this general connection we may refer to two important recent works on Egypt, both by former students of eminent geographers. In "Ewiges Stromland: Land und Mensch in Agypten" (Stuttgart, 1926), Alfred Kaufmann, who studied under Alfred Hettner and who for some years was director of the German School in Alexandria, has "laid particular emphasis upon the close connections between man and land and upon the development of culture as circumscribed by the natural limitations of the land." Henri Lorin, author of the broad survey entitled "L'Égypte d'aujourd'hui: Le pays et les hommes" (Cairo, 1926), was a pupil of the late Paul Vidal de la Blache. His book is divided into four sections, dealing in order with the physical, regional, economic, and political geography of Egypt.

Natal as a Source of Tanning Material. "For some time past the question of future supplies of vegetable tanning material has been a matter of some anxiety in the leather industry, not only of the United Kingdom but throughout the world." The Imperial Institute has taken up the question as regards the United Kingdom which, it is pointed out, derives more than half its requirements from without the Empire, the most important single source being Argentine quebracho. In its *Bulletin* the Institute is publishing a review of the situation—the October, 1927, number being devoted to the barks, chief of which is the wattle. Geographical interest lies primarily in the successful transplanting of the industry.

In 1880 the tannin-producing wattle, indigenous to Australia, was introduced into South Africa, where its cultivation has been so greatly extended, particularly in Natal, that it has given rise to one of the chief industries of the country. A suitable climate, a plentiful supply of cheap labor, and a local market for the wood as mine props and fuel have been the encouraging factors. Other parts of the Empire where the industry is proving successful are the highlands of Kenya Colony and the hills of southern India, in both of which areas natural conditions are highly favorable.

On the other hand Australia, once the only commercial source of the bark, has insufficient for domestic consumption and imports it from Natal. The Australian industry has been dependent on the natural forests, and those favorably situated for exploitation have been depleted by general destruction of the trees.

AUSTRALASIA AND OCEANIA

Land Utilization in Hawaii. In "The Economic Geography of Hawaii" (*Univ. of Hawaii Research Publ. No.* 2.), Otis Willard Freeman discusses the highly specialized types of land utilization which exist in the Hawaiian Islands. Although the total land area of the islands is less than that of New Jersey and only 10 per cent of it is under cultivation, the annual agricultural exports of Hawaii amount to about $110,000,000, a per capita value of nearly $400.

Similarities in origin and in geological history make it possible to distinguish corresponding physiographic regions on all the islands. These regions are, in turn: the beaches; the coastal plains, deltas, and alluvial slopes; the recent volcanic flows and flow margins; the older sloping flow surfaces; and the mountain tops which may form flat swampy plateaus, narrow serrated ridges, or high treeless domes. In general, each physiographic zone is characterized by a particular utilization of the land. The zones, however, are seldom continuous, nor is the utilization of them complete.

The beach zone consists of raised coral reefs and sand dunes. Here the chief activity is fishing; the Hawaiians have augmented their natural fish supply by constructing many fish ponds in the shallow waters along the shore.

The coastal plains, deltas, alluvial slopes, and valley floors are flat and easily drained or irrigated. Rice, cultivated by hand in fields too small for the use of modern machinery, is the main crop. Although two crops can be grown each year, poor

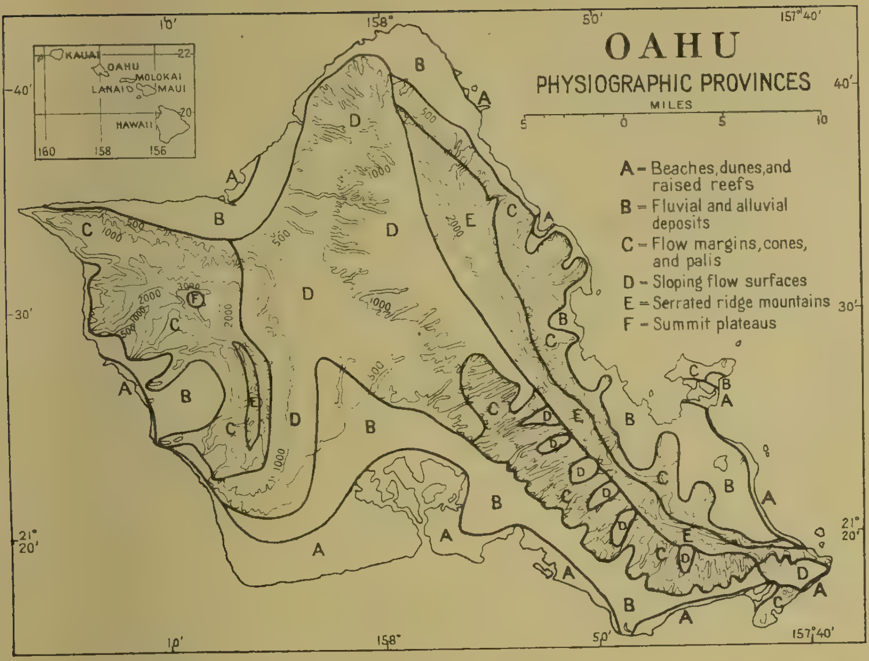
OAHU
PHYSIOGRAPHIC PROVINCES
MILES
5 0 5 10
A – Beaches, dunes, and raised reefs
B = Fluvial and alluvial deposits
C – Flow margins, cones, and palis
D – Sloping flow surfaces
E = Serrated ridge mountains
F – Summit plateaus
KAUAI
OAHU
MOLOKAI
LANAI
MAUI
HAWAII
160
158
156
22
20
10'
158°
50'
157°40'
40'
30'
21° 20'

FIG. 1

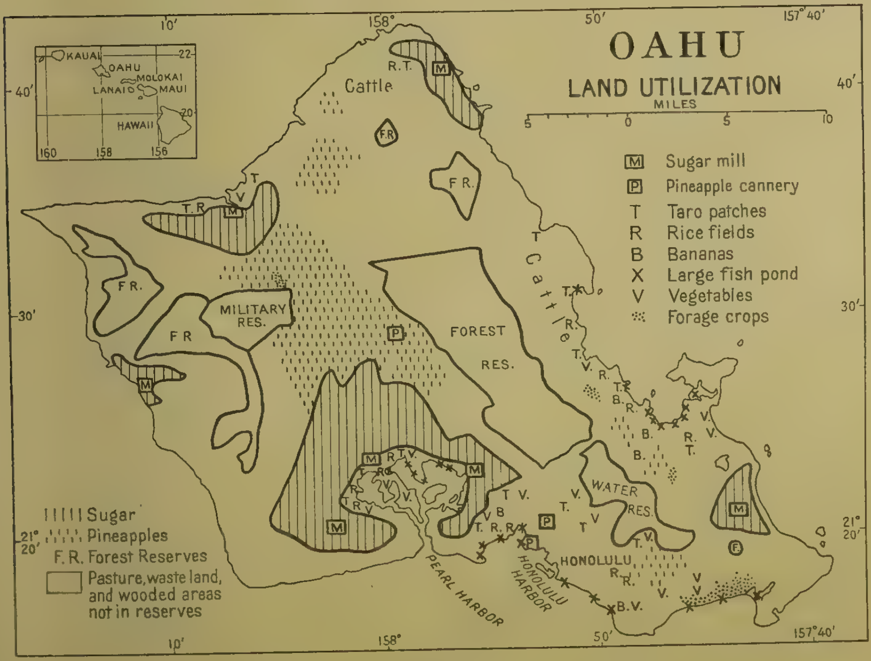

FIG. 2

FIGS. 1 and 2—Sketch maps of the island of Oahu to illustrate the close correlation between the types of land utilization and physiography. Scale approximately 1:630,000. Redrawn from Freeman's Figures 2 and 15.

methods of cultivation coupled with a distaste for the local rice on the part of the Japanese residents have caused a decided decrease in the rice acreage. Taro, one of the greatest food producers per acre in the world, is also grown in this zone. Taro does not exhaust the soil, is easy to raise, and has few parasites. Here, too, are found Chinese bananas, fifth in importance among Hawaiian exports. There are no large banana plantations; and lack of coöperation, competition with the West Indies, and the perishability of the fruit have retarded the exploitation of this crop. Some sugar cane is also raised.

Sugar cane, the most important Hawaiian crop, is dominant on the old flow surfaces and on the gentle slopes below 1200 ft. Over the greater part of the low plains where the cane is grown the rainfall is insufficient for the demands made upon it. Hence irrigation with its attendant ditching, piping, and tunneling must be employed. The perishable characteristics of the cane as well as its bulk make it imperative to convert the cane into raw sugar on the spot. The Hawaiian sugar industry is favored by good soil and climate, the longevity of the cane, liberal use of fertilizer, sufficient labor supply, progressive management, local coöperation and the United States tariff. The increase in production in the last twenty years is due not so much to increase in area in cane as to larger yield per acre. Although suitable land is still available, limitations in the water supply are becoming a determining factor in the future growth of the industry.

Pineapples are grown in the same physiographic zone as the sugar cane but on the rough land and steep hillsides above the cane fields up to an elevation of about 2200 feet. Since pineapples do not need irrigation, this industry has expanded, not at the expense of sugar cane, but of pasture and waste land. The virtual monopoly of the canned pineapple industry which the Hawaiian Islands enjoy has been made possible by the favorable climate, by the use of land better suited to pineapple culture than to anything else, and by scientific management. The employment of special machinery, utilization of by-products, sufficient local capital, advertising, and an early start have all contributed to the phenomenal growth of this industry. Not being as bulky as the sugar cane, pineapples are shipped to central canneries whence the canned product provides freight to the mainland whenever sugar exportation is slack.

The flow ends, the newer flows, and the steepest valleys, as well as the upper parts of the volcanoes, are suitable for grazing. This industry is favored by green feed throughout the year, a local demand in excess of the supply, land too rough for crops, an absence of parasites, and a native who is a natural cowboy. On the other hand the ravages of the wild goats, the lack of water in some localities, the poor quality of the cattle, and some introduced injurious plants are handicaps. There are, however, a few great cattle ranches, and the possibilities of expansion are large. Most dairy products are still imported from the mainland. Coffee culture is an important local utilization of steep, rough lava flows, and coffee is one of the few Hawaiian crops cultivated by independent farmers.

There is no commercial lumbering on the islands at the present time. The forests on the flat swampy plateaus and on the narrow ridges are chiefly valuable for water conservation. For this important purpose forest reserves of more than 96,000 acres have been established.

Estimates of Marine and Fluvial Erosion in Hawaii. The relative rates of erosion by marine and subaerial forces will always be of interest to those who recall the controversy over peneplains and plains of marine denudation. But though the fires of this controversy have fortunately died down, it must be admitted that the proof of the greater effectiveness of erosion by subaerial forces has rested on general argument rather than quantitative proof. C. K. Wentworth has taken advantage of the new topographic maps of the Hawaiian Islands, issued by the U. S. Geological Survey, and of his own residence of a year in the Islands, to give us some computations (*Journ. of Geol.*, Vol. 35, 1927, pp. 117–133). A restoration of the original symmetrical flow slopes of the volcanoes was first made, and the volumetric departures of the present surface from this ideal form were computed. Restoration of flow slopes and calculation of the volume eroded were carried on many years ago by H. H. Robinson in his study of the San Francisco Volcanic Field, Arizona (*U. S. Geol. Survey Professional Paper 76*, 1913, pp. 49–51 *et al.*). Robinson expressed the volume eroded in per cent of the total volume of the cone. Wentworth presents his figures in mile feet (1 foot deep over a square mile) or in depth of removal over the area in feet. Marine erosion has also been computed by systematic measurements of the cliff height to determine mean height. This quantity is the base of a triangle whose other two sides are the extension of the slope of the volcanic cone and the submarine profile. The area of this triangle multiplied by the length of coast gives the volume.

Obviously on comparing the results of these calculations the assumption is made, as pointed out by Wentworth, that fluvial and marine erosion began together on the completed slopes of the volcanic cones. H. T. Stearns, in a forthcoming report on the Kau district of Hawaii, has demonstrated that early valleys of large size have been filled with later flows. H. S. Palmer (The Geology of the Honolulu Artesian System, Appendix to Rept. Honolulu Sewer and Water Commission for 1927, Fig. 13) has contoured from well records the surface of the basalt under the cover of the Honolulu coastal plain. Here valleys coincident in position with the subaerial valleys of the mountains back of the city extend for 1000 to 1300 feet below sea level. Thus a former elevated position of the land is demonstrated. In general, however, Wentworth's assumption appears to be correct. The present cycles of erosion, fluvial and marine, began simultaneously on completion of the volcanic cones.

Using figures for selected areas, Wentworth shows that for a large part of the erosion cycle the quantity of material removed by fluvial action increases at a rate midway between the first and second power of the quantity removed by marine erosion. For the islands as a whole (Table VII) the quantity of fluvial erosion is seven times that of marine erosion. Thus even in the stormy seas of the mid-Pacific, subaerial erosion is much more effective than marine erosion. On the average continental coast the effectiveness of waves is doubtless proportionably lower.

The attempt to use the quantities of material removed by fluvial erosion as a measure of the age of the islands in years appears to be less happy. Obviously any errors in the basic assumption of a single cycle of erosion are here magnified, whereas in the comparison of rates it may be supposed, for lack of specific knowledge, that the quantities of fluvial and marine erosion obtained in the calculations may be more or less equally affected by partial cycles of erosion induced by uplift, depression, or renewed outpourings of lava.

The advantage of these quantitative studies lies, however, not only in the successes but also in the failures or partial failures. The rigid analysis required by mathematical expression makes evident the gaps in our knowledge and leads to renewed effort to accumulate facts.

KIRK BRYAN

GEOGRAPHICAL NEWS

An Announcement Regarding the New Journal of Abstracts in the Social Sciences. The Social Science Research Council announces plans to establish a Journal of Abstracts in the Social Sciences. These plans are the result of five years study by a committee of the Council which has canvassed the situation with respect to the needs, resources, and purposes to be served by a comprehensive abstract service in the Social Sciences.

A substantial subsidy, a sum of $500,000, available over a period of ten years, has been provided by the Laura Spelman Rockefeller Memorial.

In its report to the Council at Hanover, N. H., in August, 1927, the Committee on Social Science Abstracts stated the need for abstracts in the following paragraphs.

"The founding of the Social Science Research Council is itself a recognition of the fact that leaders in the social sciences are convinced that research in these disciplines is greatly in need of stimulation and direction and, further, that the scholars in these fields should be brought closer together for the consideration and solution of common problems. On the other hand, the deliberations of the Committee on Social Science Abstracts, and much of the information gathered by it, clearly bring out the fact that one great obstacle to the doing of truly scientific research in these fields lies in the tremendous mass of the materials to be considered and in the relative, if not quite complete, lack of appropriate tools for attacking it. There are so many books, pamphlets, and reports constantly being published and so many periodicals both scientific and semi-scientific steadily pouring from the printing houses both here and abroad, that it is physically impossible for any one to keep abreast of all the literature even in his own special field of work. For this reason, also, and in making a courageous effort to read what he should, he is likely to take first the publications obviously in his own special field and, for lack of time to do more, to become increasingly oblivious of what is being done in other disciplines upon the same subjects. Thus artificial departmental lines tend to become sharper, and in his mind the social sciences stand as distinct and separate fields.

"To overcome these difficulties, a journal is proposed which will save an almost infinite amount of time and labor on the part of research workers, by giving them in one journal complete citations and short but objective abstracts of all important new materials, and will at the same time draw together the several disciplines by serving them all through one journal based upon some systematic classification and improved by numerous cross references to the materials in other fields. Other important advantages of such a publication could easily be stated. It will save much duplication and waste of effort, it will appraise the worker of the existence of other specialists working on his problems and stimulate correspondence between them, it will call attention to new methods of research, it will serve as a permanent record of the work already accomplished, and will in many other ways promote the healthy development of the sciences to which it relates."

The Social Science Research Council has appointed an Organizing Committee consisting of the following scholars and charged with the responsibility of organizing and establishing *Social Science Abstracts:* Dr. Isaiah Bowman, American Geographical Society; Dr. Davis R. Dewey, Editor of the American Economic Review; Dr. Carlton Hayes, Professor of History, Columbia University; Dr. Frederic A. Ogg, Editor of the American Political Science Review; Dr. Frank A. Ross, Editor of the Journal of the American Statistical Association; Dr. Clark Wissler, Professor of Anthropology, Yale University; and Dr. F. Stuart Chapin, chairman, Professor of Sociology, University of Minnesota.

To assist the Organizing Committee a number of advisory committees have been appointed in the fields of cultural anthropology, economics, history, human geography, political science, sociology, and statistics. These advisory committees have been asked to suggest: (1) the names of scholars who may be considered for the positions of salaried editors and unsalaried consulting editors; (2) to draw up a scheme of classification adequate to the needs of the systematic grouping of materials from their respective fields of specialization within the social sciences.

Since the Council is made up of delegates from the national learned societies in the fields of anthropology, economics, history, political science, psychology, sociology, and statistics, the purposes of the Council in its efforts to further coöperative scientific research in the social sciences are best served by devoting *Social Science Abstracts* to the fields of cultural anthropology, history, human geography, political science, sociology, and statistics, broadly construed.

Social Science Abstracts will be issued monthly during the year, and in each issue will appear systematic abstracts of new information published in the fields indicated for the preceding month or months. *Social Science Abstracts* will be printed in English in this country, but it will attempt to cover the social science literature of the world as originally published in all languages.

Negotiations are under way to establish a satisfactory basis of coöperation with the Committee on Intellectual Coöperation of the League of Nations in working out a *modus operandi* with the arrangements for economic abstracts undertaken by this international organization.

The test of published materials to be abstracted will in general be the criterion of new information, in the sense of important factual studies and contributions to theory and opinion, in the fields of the social sciences indicated. This will require the careful scrutiny of articles in periodicals, pamphlets, bulletins, monographs, and new books. It is conservatively estimated that the annual number of abstracts will run to fifteen or twenty thousand titles the first year. The abstracts will be cross referred, and annual indexes will be published. It is hoped that the first number of *Social Science Abstracts* may be published within the present calendar year.

F. STUART CHAPIN,
Chairman of the Organizing Committee

OBITUARY

MAJOR GENERAL GEORGE WASHINGTON GOETHALS. Major General Goethals died in New York City on January 21, 1928, in the seventieth year of his age. His outstanding achievement in a distinguished military career was an event of very great geographical importance. In the words of the inscription on the Cullum Medal of the American Geographical Society presented to General Goethals in 1917, he, as builder of the Panama Canal, "fulfilled the ancient dream of Gomara of a highway between the Atlantic and the Pacific and thereby transformed forever the geographic relations of the commercial world" (see *Geogr. Rev.*, Vol. 3, 1917, pp. 396–397).

From 1907 to 1914 General Goethals was chief engineer and administrator on the Isthmus of Panama. He was not only an exceptionally able engineer but also a man of remarkable executive ability. Not less notable than the engineering feat is the work in sanitation that has made the Canal Zone a model for tropical countries, transforming it "from a pestilential area of difficult and dangerous travel to a land where the death rate is less than that of some of our large cities" (R. M. Brown: Five Years of the Panama Canal: An Evaluation, *Geogr. Rev.*, Vol. 9, 1919, pp. 191–198). Other problems involved in the establishment of a temperate zone community in the tropics lay in the distance from the seat of home authority and the zone's complete dependence on the outside for supplies. Economic and labor problems and city planning had to be considered. The range of activities is well described in a series of papers by men in charge in the volume "The Panama Canal: An Engineering Treatise" edited by General Goethals (New York, 1916). And not least was the problem of administration, described by General Goethals himself in "Government of the Canal Zone" (Princeton, 1915) as "a novel problem in government."

On the completion of the Canal in 1914 General Goethals was appointed Governor of the Canal Zone, in which capacity he served until 1917, thus perfecting the working arrangements of the undertaking. "There are mountains, but there are also hands; give me the resolve and the task will be accomplished. If determination is not lacking, means will not fail." Gomara's vision had been realized.

GEOGRAPHICAL REVIEWS

RECENT WORKS ON THE ARCHEOLOGY OF CENTRAL AMERICA

T. A. JOYCE. **Report on the Investigations at Lubaantun, British Honduras, in 1926.** Plans, diagrs., ills. *Journ. Anthropol. Inst.*, Vol. 56, 1926, pp. 207–230.

THOMAS GANN. **In an Unknown Land.** 263 pp.; map, ills., index. Charles Scribner's Sons, New York, 1924. $5.00. 9 x 6 inches.

THOMAS GANN. **Mystery Cities: Exploration and Adventure in Lubaantun.** 252 pp.; ills., index. Charles Scribner's Sons, New York, 1925. $5.00. 9 x 6 inches.

THOMAS GANN. **Ancient Cities and Modern Tribes: Exploration and Adventure in Maya Lands.** 256 pp.; map, ills., index. Charles Scribner's Sons, New York, 1926. $5.00. 9 x 6 inches.

GREGORY MASON. **Silver Cities of Yucatan.** xvii and 340 pp.; map, ills. G. P. Putnam's Sons, New York and London, 1927. $3.50. 9 x 6 inches.

Tribes and Temples: A Record of the Expedition to Middle America Conducted by the Tulane University of Louisiana in 1925. Vol. 1, v and 237 pp.; maps, ills.; Vol. 2, iv and pp. 239–536; map, ills., bibliogr., index. The Tulane University of Louisiana, New Orleans, 1926, 1927. $15.00. 11 x 8 inches.

MANUEL GAMIO. **Cultural Evolution in Guatemala and its Geographic and Historic Handicaps,** *Art and Archaeology*, Vol. 22, 1926, pp. 203–221; Vol. 23, 1927, pp. 17–32, 71–78, 129–133.

S. K. LOTHROP. **Pottery of Costa Rica and Nicaragua.** Vol. 1, xxvii and 225 pp.; map, ills.; Vol. 2, xviii and pp. 227–529; ills., bibliogr., index. *Contribs. Museum of the Amer. Indian, Heye Foundation*, Vol. 8, 1926, New York. $12.50. 10 x 7 inches.

S. K. LOTHROP. **Stone Sculptures from the Finca Arevalo, Guatemala.** Map, ills. *Indian Notes*, Vol. 3, 1926, pp. 147–171.

S. K. LOTHROP. **Pottery Types and Their Sequence in El Salvador.** Diagrs., ills., bibliogr. *Indian Notes and Monographs*, Vol. 1, 1927, pp. 165–220.

S. K. LOTHROP. **Tulum: An Archaeological Study of the East Coast of Yucatan.** Maps, diagrs., ills., bibliogr., index. *Carnegie Instn. Publ. No. 335*, Washington, 1924.

S. G. MORLEY. **Investigation in [Middle American] Archaeology.** Ills. *Carnegie Instn. Year Book No. 25 for 1925–1926*, Washington, 1926, pp. 259–286.

A. M. TOZZER. **Time and American Archaeology.** Maps, ills. *Natural History*, Vol. 27, 1927, pp. 210–221.

The archeological exploration of an area falls into two phases. The first is the more or less helter-skelter discovery of sites and objects, with a geographic appraisal of the data gained. The second phase comprises the focusing of the scattered finds into regional groups and the resolution of the relationship between zones into problems of sequence, answerable in part by information of a chronological nature.

This, for example, is the course obtaining in the southwestern United States, the archeological area historically best known in the New World.

In the Maya area, on the other hand, a somewhat paradoxical situation has developed. A more or less absolute chronology exists without a sequential archeology comparably accurate. This condition arose from the brilliant studies of Goodman, Bowditch, Morley, and Spinden on the Maya calendar, by which the dates inscribed on stelae or buildings may be read to yield a time count not only significant within the area but also reducible into units of Christian chronology. Since outside of the limited homeland area of the Aztec there exists no transliterated calendar system and since the Aztec calendar covers only a very limited period before the Conquest, it will be seen that a time count with a range from at least 96 B. C. to about 650 A. D. in one system and, in another abbreviated form, up to and beyond the occupation of Yucatan by the Spaniards, would attract a concentration of effort by investigators.

Furthermore, the natural conditions of the region—a tropical, comparatively pathless bush, tend to prevent excavation on any scale for the history of material culture. Thus except for Spinden's unequaled memoir on Maya art (1917), which is concerned chiefly with stone carving, we have little or nothing definite on the material culture of the Maya. The minor arts of pottery, weaving, manufacture of stone utensils and ornaments, etc., which form the foundations of an archeology, are unclassified and unappraised for lack of a corpus of material of reliable provenience.

However, the remarkable success in the Southwest of "dirt archeology," i. e. the examination by excavation of stratified sites to find, through changes in the material culture, time sequences and cultural relationships, has led to the adoption of these methods by some of the workers in the Maya area. The relation of man to his environment cannot be envisaged clearly without a conception of the dates of his inventions or the sources of his adaptations.

The difficulties of Maya research are well illustrated by Mr. Mason's readable book, "Silver Cities of Yucatan." Contained in its pages are many data as to conditions for travel by land and sea in the eastern portion of the Yucatan Peninsula. The same sort of information, invaluable to the traveler, is to be found in Dr. Gann's three volumes. His archeological data illustrate lamentably well the lack of correlation between Maya dates and the material encountered in excavation. The greater part of his archeological description is contained more fully in his formal presentation, "The Maya Indians of Southern Yucatan and Northern British Honduras," *Bur. of Amer. Ethnology, Bull. 64,* Smithsonian Instn., Washington, 1918.

"Tribes and Temples" is a most successful combination of scientific information and the intellectually lighter aspects of travel. All workers in the parts of Vera Cruz, Tabasco, and Chiapas traversed by Mr. Frans Blom must owe him an everlasting debt of gratitude for his exact location of ruins, his exhaustive collection of published and unpublished data bearing on the region, and his scientific recording and interpretation of his finds. Once more, however, we feel the tragedy of the situation in Maya archeology: the dates are exact, but the correlation between the time factor and the material culture is vague.

The chief archeological project in the Maya area is that of the Carnegie Institution. Since the work of this institution is, as yet, far from complete and the publications are brief resumés produced on each season's work, it is not possible to comment on final results. The scope and broad conception of the work in hand are well given in the words of the director, Mr. S. G. Morley, "This [Guatemalan] contract, together with the one in force with the Mexican Government, brings under the Institution's purview possibly the three most strategic sites for a comprehensive study of the Maya civilization that can be found. Uaxactun is the oldest city of the Old Empire now known, based upon the evidence of the dated monuments (68 to 630 A. D.). Chichen Itzá [the chief center of the Institution's activities] is the oldest city of the New Empire, and was apparently the second place of any importance to be founded in the Peninsula of Yucatan (531 to 1448 A. D.). Tayasal was the last independent Mayan stronghold, and resisted the Spanish arms for a century and a half after the Conquest of Yucatan (1448 to 1697 A. D.). It has the further intimate connection with one of the other two sites, in that it was founded by the Itzá after the destruction of

Chichen Itzá, thus bringing under the Institution's observation and study 16 continuous centuries of ancient Maya History."

The vastly important zone between the Petén and the Copan region is being covered by the British Museum. Mr. Joyce and his associates are boldly attacking the "dirt archeology" of that portion of the Maya area. The preliminary report gives hopeful indications in that three apparently sequential architectural styles have been discovered. Doubtless in time pottery and stone work will have been correlated with these three types of building. Once more the chronological data are of little avail in a city without monuments. However, in the near future some link may be established between Lubaantun and Uaxactun. The many monuments and the long occupation of the latter may furnish a gauge for the history of southern British Honduras and the Petén through the correlation of its monuments with its culture phases.

In western Guatemala Dr. Gamio, working for the Archaeological Society of Washington, has been able to distinguish transitions between the "Archaic" culture of the Valley of Mexico and that of the western Maya. Later perhaps there will be found an actual superposition of objects which will clarify that aspect of Middle American history before the rise of the Maya tribes into civilized states.

Dr. S. K. Lothrop's "Tulum" covers the results of an exhaustive above-ground study of Tulum and sites adjacent to it along the east coast of the Yucatan Peninsula. By means of a careful observation of changes in architectural detail through additions to buildings, by a casting up of structural features definitely Maya and non-Maya, and by information derived from native myths and Spanish historians, he was able to distinguish five periods. The first is the Colonization Period (433–689 A. D.) based on an Old Empire stela found at Tulum and on native traditions (the books of Chilam Balam) that the region was occupied by Maya. The second is the Dark Ages (689–985 A. D.) of which there are no remains extant. The third is the Period of the League of Mayapan (985–1201 A. D.) in which the cities in western Yucatan rose to splendor; but the east coast buildings of this epoch are scant in number and provincial in style. The fourth is the "Toltec" Period (1201–1485 A. D.), to which belongs the majority of the east coast remains. A final period comprises the decadence through pestilence, famine, and civil war of these eastern cities. This book is one of the first comparative and frankly historical essays on Central American architecture. It sets a standard for the regional studies of sequences in cultural manifestations necessary before the history of a nation's civilization can be evolved.

Dr. Lothrop's "Pottery of Costa Rica and Nicaragua" is an exhaustive study of the distribution and classification of the different styles of pottery found throughout that area. It gives one an aspect of a generalized Highland culture of considerable geographical range and of indeterminate basal affiliations, virtually out of the sphere of Maya influence and nearing Isthmian types and styles. In a short paper on the pottery sequence of Salvador, Lothrop describes the discovery of a simplified form of the Mexican "Archaic" underlying the other cultures and separated from them by a thick layer of volcanic ash. Above this ash layer were bits of Maya-influenced pottery. A third group comprises wares attributable perhaps to the Nahua-speaking Pipil, but it is noteworthy that elements considered hitherto "Archaic" are to be found in this latest pottery. In another short paper Dr. Lothrop discusses some stone carvings found in western Guatemala, where he discovered a type of sculpture demonstrably pre-Maya but relatable to other Highland styles found to the southeast in Costa Rica and northwest in Mexico.

Dr. Tozzer boldly sets the stage for future discussions of New World relationships by bringing together the data known to workers of today. In his paper one sees that it is through work like Dr. Lothrop's that we may most surely reconstruct the past. The growing realization of the importance of the relationships between the Maya and the pre-Maya, and the Maya and the Highland cultures shows the necessity for scientific excavation as a means of determining these phases. Yet it is equally clear that only through the medium of the Maya calendar may the sequences of civilization in the New World be reduced to units of absolute time. It must also be remembered that many times the number of years covered by the Maya calendar must have elapsed before that time count began to function and that a large portion of New World history must be recorded in terms of sequence, not years.

George C. Vaillant

Reproductions of Early Maps

Emerson D. Fite and Archibald Freeman. **A Book of Old Maps Delineating American History from the Earliest Days Down to the Close of the Revolutionary War.** xvi and 299 pp., maps, index. Harvard University Press, Cambridge, 1926. 16½ x 11½ inches. $25.00.

Arthur L. Humphreys. **Old Decorative Maps and Charts.** With illustrations from engravings in the Macpherson collection, and a catalogue of the atlases, etc., in the collection, by Henry Stevens. viii and 51 and xliii pp., and 79 plates of maps; ills. Halton & Truscott Smith, Ltd., London; Minton, Balch & Co., New York, 1926. $25.00. 12½ x 10 inches.

"A Book of Old Maps" is a scholarly work. The maps reproduced have been carefully selected to illustrate different phases of American history. Unfortunately, however, the reduction of the larger originals is too great to permit of intensive study of their details. Exploration along the coasts of the New World is revealed in a group of world maps; and regional maps show the advance of the pioneers into the interior, the establishment of settlements, and the demarcation of town, county, province, and state boundaries. Military maps display campaigns and battles of the French and Indian Wars and of the Revolution. Town plans help us visualize Boston, New York, and Philadelphia in the Colonial times. Each of the 73 plates is accompanied by several columns of letter press, often entertainingly written and well documented.

There are occasional misleading statements. For example, Ptolemy's "Geography" was hardly "the standard work on geography throughout the Middle Ages," for it was virtually unknown in western Europe until its translation into Latin in the fifteenth century. What is the justification for translating *Sacharuum regno* on the Lenox globe as *Sugar Country*? The name certainly comes from the Sacarum Regio or Region of the Sacae of Ptolemy and other ancient authorities. One is also tempted to wonder whether it might not have been well to explain, in connection with the anonymous world map in the Bibliothèque Nationale, that La Roncière's theory ascribing this map to Columbus has been subjected to severe criticism. The uninitiated might easily suppose from Professor Fite's and Mr. Freeman's text that the theory had been generally accepted. These are minor matters, however, which detract but little from the value of a splendid and thoroughly worth-while publication.

Mr. Humphreys' volume is designed primarily as a guide to the collector of decorative maps. It contains 79 reproductions—some in color—of sheets from editions of Ptolemy and other atlases dating from the sixteenth to the eighteenth centuries. Many of these maps are extraordinarily beautiful. The introductory text relates for the most part to the biographical, cartobibliographical, and technological phases of the history of cartography rather than to its geographical aspects. No attempt is made to describe the individual maps or to interpret the features shown upon them. Henry Stevens supplies as an appendix a useful annotated catalogue of atlases, chart books, etc., in the fine collection of Mr. A. G. H. Macpherson, upon which Mr. Humphreys' volume is based.

It is a pity that such a handsome and superficially attractive book as that of Mr. Humphreys should be marred by lack of precision in the historical introduction.

Ptolemy was not "the first to realise and describe the extent of the surface of the globe" (p. 4); nor is it true that Ptolemy "has preserved for us all that was known of geography in the first centuries of our era" (p. 13); nor did Ptolemy's "Geography" stand "as the highest authority for more than twelve hundred years" (p. 16). Why does Mr. Humphreys say that Ralph Higden's map of the late fourteenth century is the earliest example of a colored map, although earlier examples are reproduced in books which he himself cites? On page 38 Mr. Humphreys laments the decline in the art of map making after the close of the seventeenth century. "As surely as map making became a lucrative business not only did its scientific value decrease but its artistic touches gradually disappeared . . . ". It is quite true that the eighteenth-century atlases are not comparable to the work of Mercator, Ortelius, and Blaeu; but we should be misled were we to gain an impression that the "scientific value" of map making was decreasing just at the time when genuinely accurate methods of triangulation, of determining positions by astronomical means, and of representing relief were being worked out. If not from the decorative, certainly from the scientific, point of view cartography made great strides during the eighteenth century.

Drake's Voyage Around the World

Henry R. Wagner. **Sir Francis Drake's Voyage Around the World: Its Aims and Achievements.** xii and 543 pp.; maps, ills., index. John Howell, San Francisco, Cal., 1926. 11 x 8 inches.

John W. Robertson. **Francis Drake and Other Early Explorers Along the Pacific Coast.** 290 pp.; maps, ills., index. The Grabhorn Press, San Francisco, 1927. 10½ x 7¼ inches.

Sir Francis Drake's Voyage Round the World 1577–1580: Two Contemporary Maps. Printed by order of the Trustees, Sold at the British Museum, and by Bernard Quaritch, Ltd., Oxford University Press and Kegan Paul, Trench, Trubner & Co., Ltd., London, 1927. 13½ x 9¾.

N. M. Penzer, edit. **The World Encompassed and Analogous Contemporary Documents Concerning Sir Francis Drake's Circumnavigation of the World.** With an Appreciation of the Achievement by Sir Richard Carnac Temple. lxv and 237 pp.; maps, ills., index. The Argonaut Press, London, 1926. 10½ x 8 inches.

Stirring exploit that it was, Drake's voyage around the world did not enlarge the horizon of geographical knowledge to any substantial degree. Except in the vicinity of Cape Horn no hitherto unknown waters were traversed, no unknown lands coasted. Spanish or Portuguese sailors had everywhere preceded Drake, and Drake himself made use of Spanish and Portuguese maps. Indeed, however much we may admire the heroism and nautical skill of Drake and his company, if estimated strictly from the geographical point of view his voyage belongs in much the same category as certain of the great feats of mountaineering or of aerial navigation of recent years, the geographical importance of which may easily be exaggerated. Merely to go from one place to another, however sensational or unusual the method of travel, is not in itself a contribution to geography.

Drake's circumnavigation, therefore, was not one of the major events in the history of geography. The four publications under review nevertheless reveal to us something of the status of geographical knowledge in the sixteenth century as a background for the details of "the famous voyage." Our interest in these books centers upon this background. Wagner and Robertson give much space to maps and other geographical matters. Students of the period will also be grateful to the British Museum for the admirable reproductions of two important contemporary maps showing Drake's route: "La Heroike Enterprinse faict par le Signeur Draeck d'avoir cirquit toute la terre," Antwerp (?), 1581 (?) and the "Vera totius expeditionis nauticae descriptio D. Franc. Draci," etc., Amsterdam (?), 1590 (?).

Wagner's bulky volume embodies the results of prolonged and minute research. Only about half of the 543 pages are devoted to the main part of the text: a narrative and interpretation of the voyage in the light of the English and Spanish materials available. In Part II the sources are critically estimated, and the more essential documents are reprinted and translated. The notes, relegated to the back of the book, are extremely full. Wagner holds that there is no just basis for the theory advanced by Sir Julian Corbett and Mrs. Zelia Nuttall that Drake was primarily a statesman and empire builder, whose purpose was the establishment of an English colony on the west coast of North America. The voyage was undertaken, rather, in the interests of English trade, Drake's object being the establishment of commercial relations with the spice islands. An advantageous agreement completed with the Sultan of Ternate was to be a first step in this direction.

Robertson's volume is truly exquisite from the bookmaker's point of view—and it is correspondingly expensive. After sections on Cortes, on the Indians of California, and on the Jesuit explorations in Lower California and about the Colorado River, the author turns to Drake. An extended analysis is given of the controversies that have been waged about the exact location of Drake's anchorage upon the California coast. Robertson believes it must have been in the vicinity of San Francisco Bay but judiciously refrains from picking out any one place. He holds that neither the elaborate arguments of G. C. Davidson in favor of Drake's Bay (see *Bull. Amer. Geogr. Soc.*, Vol. 40, 1908, pp. 449–469, and *Geogr. Rev.*, Vol. 2, 1916, pp. 373–374) nor those of Wagner in favor of Trinidad, farther north, will stand critical scrutiny. This whole problem—after all, like that of the first landfall of Columbus, one of no great intrinsic historical or scientific importance—has called forth a lavish expenditure of scholarly energy in attempts at its solution.

Mr. Penzer has given us a handsome edition of "The World Encompassed," that embroidered and exaggerated narrative of Drake's voyage based on the journals of Fletcher, the chaplain.

AN ECONOMIC FACTOR IN THE HISTORY OF SEA POWER

R. G. ALBION. **Forests and Sea Power: The Timber Problem of the Royal Navy 1652–1862.** xv and 485 pp.; maps, diagr., ills., bibliogr., index. (Harvard Economic Studies, Vol. 29.) Harvard University Press, Cambridge, 1926. $5.00. 9 x 6 inches.

From childhood most of us have known and accepted the obvious fact that Britain's existence has depended upon her sea power; but how many of us have ever asked whence she obtained the materials of which her fleets were built? And how many have reflected that if those materials came from outside the empire, Britain's foreign policy in certain instances must have been determined by the necessity of keeping open the way to those sources of supply? These two points are among the principal topics dealt with in this book.

In the early chapters the reader is introduced to the varieties of wood required in naval construction, and the history of England's diminishing woodlands is recounted. Then comes the *pièce de résistance*. When forced to look abroad for masts, timber, and naval stores, Britain turned to the Baltic, especially to Riga, and on various occasions between 1650 and 1815 she was obliged either to display or to use force in order to prevent the supply from being cut off. Denmark, Sweden, the Netherlands, and Russia—all had to be dealt with on this account sooner or later. Sometimes a display of force was sufficient; sometimes, as at Copenhagen in 1801 and 1807, England gave battle in order to keep the Baltic open.

When the Danes interrupted the Baltic mast supply in 1652, the Navy Commissioners accepted American sticks as a substitute; and for a century and a quarter thereafter their largest masts, though by no means all their timber, were imported from New England. Systematic conservation of white pine for the navy began with the Massachusetts charter of 1691 and ended (in New England) with the American Revolution. But Britain scorned the white oak of America; and, though the live oak of the southern provinces was actually superior to English oak, she failed to utilize it. Professor Albion attributes England's neglect of the live oak to the fact that the southern colonists had other staples upon which to base their commerce. But this hardly excuses the British Government, and it is heartening to learn that the United States did better in this respect. In 1799 and 1800 our Government purchased two islands off the Georgia coast in order to assure itself of a supply of this invaluable naval timber.

Chapter after chapter of this book brings home to the reader the prejudice and stupidity of the British naval authorities and the rottenness of their administration from the time of Pepys to the time of St. Vincent; and he marvels more than ever that England not only survived every crisis but came out on top. If the outcome had been the reverse, historians would have pointed out that it was the inevitable consequence of a thoroughly corrupt government. Here we have an administration that could hardly have been worse, yet England weathers every storm! And as if inefficiency and graft were not enough to bring about her ruin, Britain had to contend with another internal enemy the "Timber Trust." This monopoly disapproved of the rigid inspection of government purchases instituted in 1801 and refused to supply the navy with timber. The boycott continued even after the resumption of hostilities in 1803. For lack of patriotism the record of the organization is almost beyond belief. In 1804 the Navy Board surrendered to it, and for half a century afterwards the "Timber Trust" frequently dictated its own terms to the Government. Yet Bonaparte was defeated, and the British Empire continued to expand and grow rich. What is the explanation? Can it be that the strength of Britain's enemies was sapped by governments even more rotten than her own? Or is it that Destiny wins in spite of all handicaps?

Students of American colonial history will read with especial interest the chapter entitled "The Broad Arrow in the Colonies." Probably no one has made a more careful and thorough study of this subject than the author. It was not an easy task, for there were many conservation acts and it is doubtful whether even the surveyor general of the King's woods knew precisely how to interpret their overlapping provisions. But Professor Albion appears to have kept his bearings uncommonly well and to have grasped both the intention of the British Government and the methods employed by the surveyor general and his deputies to carry that purpose into execution.

New England antiquarians may be disappointed when they fail to find the name of Captain Thomas Coram in these pages, for locally at least he is credited with having brought about the passage of an early act of Parliament which promoted the exportation of naval stores from America and hence their production in the colonies. But it may well be that Coram was more interested in tar and turpentine than in timber, and that on that account Professor Albion purposely left him out of his narrative. More justifiable would be the objection which an ornithologist might make to the statement (p. 241) that the "Broad Arrow" was shaped like a crow's track. A partridge's track would have been a more accurate description. But these are inconsequential details that are scarcely worth mentioning in a review of so admirable a book as "Forests and Sea Power." The extraordinary amount of research upon which it is based is one of its merits. The structure is carefully planned and suggests that the author has an unusually clear and orderly mind. The actual exposition of the subject is remarkable not only for its lucidity but for the life there is in it. And the author's ability to use the English language in a straightforward manner, that is neither ponderous nor sprightly, is a valuable adjunct to his scholarship and to his enthusiasm.

Lawrence S. Mayo

ANTHROPOLOGY OF CHINA

S. M. SHIROKOGOROFF. **Anthropology of Northern China.** iv and 127 pp.; maps, diagrs. Extra Vol. 2. Royal Asiatic Soc. (North China Branch), Shanghai, 1923.

S. M. SHIROKOGOROFF. **Who Are the Northern Chinese?** *Journ. North-China Branch of the Royal Asiatic Soc.*, Vol. 55, 1924, pp. 1–13.

S. M. SHIROKOGOROFF. **Anthropology of Eastern China and Kwangtung Province.** vi and 162 pp.; diagrs., bibliogr. Extra Vol. 4. Royal Asiatic Soc. (North China Branch), 1925.

In the monograph "Anthropology of Northern China," Professor Shirokogoroff has embodied the results of his researches in the physical anthropology of eastern Asia between the years 1912 and 1918. The bulk of the material, as the title suggests, is drawn from northern China; but a great deal is brought in, for purposes of comparison, from Manchuria, Korea, and the Maritime Province of Siberia. For his effort, carried out in the face of very great difficulties and discouragements, to base our knowledge of the peoples of eastern Asia upon objective physical measurements instead of the mere subjective impressions of travelers, he deserves no little credit.

Save for what seems needless complexity in some of the numerous tables and diagrams, there is little to criticize on methodological grounds. With the intricacies of anthropometry Professor Shirokogoroff seems thoroughly familiar. But he draws far too sweeping conclusions from what are after all quite inadequate data. In many groups the actual number of individuals whose measurements he records is less than 100. In other respects also our author is inclined to base far-reaching assumptions on too slight evidence. Thus he decides (p. 104) through a process of elimination that in prehistoric times northern China, "somewhere in the basin of the Yellow and Yangtse Rivers," was "the sole possible region of habitation for the Tungus." The corollary to this would be of course that these people have since migrated northward to their present homes. But in point of fact it seems fairly certain that the movement of population in that part of Asia which the author is considering has been throughout from north to south. Chinese civilization, it is true, has spread to a certain extent in the reverse direction; but culture drifts are a very different matter from racial ones and, although often confused with them, are subject to entirely different laws.

Our author's belief in the great antiquity of the domestication of the reindeer also seems unfounded. The probabilities all point to its being a comparatively recent practice, in terms of cultural development, inaugurated by peoples familiar with the use of domestic oxen and horses on the one hand and of dog-drawn sledges on the other. Dr. Berthold Laufer in his paper "The Reindeer and Its Domestication" (*Memoirs Amer. Anthropol. Assn.*, Vol. 4, 1917, pp. 91–147), seems to have demonstrated this point quite conclusively.

Professor Shirokogoroff is quite right in insisting upon the constancy of physical types as opposed to language; he shows that the same group may have adopted Turkic, Mongol, and Tungusic dialects in turn at successive epochs, although undergoing little or no change in bodily characters. He does not, however, adhere with unvarying consistency to his own distinctions; at times, for example, it is difficult to know whether he is thinking of the Tungus as a linguistic stock or as a physical type.

The article "Who Are the Northern Chinese?" is in effect a resumé of the above monograph. The author begins with a historical sketch of the science of physical anthropology. There follows an account of the theory of a "Mongol Race," belief in which as a distinct division of mankind he finds untenable. What is usually regarded as such, he tells us (p. 3), is only "an agglomeration and amalgamation of different anthropological types." The remainder of the paper is mainly devoted to a description of the people of northern China, among whom are distinguished four types, all differing from one another in stature and in cephalic as well as other indices.

The writer assures us that, although a "Mongol Race" does not exist, it is still possible to "recognize a Chinaman" at once, owing to the presence of certain intangible characteristics which "cannot be registered by anthropometrical instruments" (p. 12). Elusive psychological factors may conceivably be in part responsible for this apparent homogeneity of aspect; but Chinese costume plays a far greater part. Few would have the temerity, unless exceedingly inexperienced, to claim to distinguish infallibly among Chinese, Koreans, and Japanese, for example in Occidental dress.

In the introductory chapter to "Anthropology of Eastern China and Kwangtung Province," Professor Shirokogoroff devotes considerable space to refuting some of his critics and concludes by giving a brief but good summary of the geographical conditions controlling movements of population from northern to southern China. Four chapters on measurements and their interpretation and comparison follow and a last chapter entitled "Anthropological Deductions in the Light of Some Ethnical and Historical Parallels."

The value of this concluding chapter, which should be the most important of all, is impaired by the author's attempt to draw conclusions from a field, that of culture history, with which he is not thoroughly familiar. He seems, for instance, to overestimate the probable cultural and linguistic differences between the ancient peoples of the Yangtze valley and their neighbors to the north, the Chinese proper of the classical period. He also refers more than once (e. g. on pp. 124 *et seq.* and p. 129, n. 3) to Aurousseau's theory that the present-day Annamites are descended from the former inhabitants of southeastern coastal China, who he believes migrated *en masse* to their present homes about the beginning of the historical period. This hypothesis, however, has been stoutly controverted by other scholars and appears to have little to recommend it. The author's pet theory of the "undoubtedly southern origin of the Tungus . . . for whom some room on the continent ought to be found" crops out again on page 134; but this determination of the ancient Tungusic habitat by a simple process of elimination, without more tangible evidence, has not met with wide acceptance.

Speaking generally, in this new work Professor Shirokogoroff, like others who have tried to generalize regarding the peoples of Asia, falls short of his full object. This is due simply to the insufficiency of existing recorded data. We have not as yet a large enough body of authentic and properly coördinated material upon which to base conclusions. His effort, however, is a sincere and praiseworthy one; and when more facts have been assembled, his labor will doubtless prove to have been far from vain.

C. W. Bishop

The Geography of Albania

Herbert Louis. **Albanien: Eine Landeskunde vornehmlich auf Grund eigener Reisen.** viii and 164 pp.; map, ills., bibliogr., index. (*Geogr. Abhandl. herausg. von A. Penck.* Ser. 2, No. 3). J. Engelhorns, Stuttgart, 1927. 9 x 6½ inches.

Dr. Herbert Louis acted as topographer with Ernst Nowack in his geological surveys for the Albanian government and spent the summers of 1923 and 1924 in the field. The work under review is the result of these explorations. The book is well documented; the bibliography of 111 entries, beginning with Leake's book (1814), is a good index to the literature apart from "travel" books. A curious omission, however, is Nowack's paper "A Contribution to the Geography of Albania" published in this journal (Vol. 11, 1921, pp. 503–540).

The first sixty pages consist in an excellent summary of the geography of Albania, in which recorded facts are well selected and concisely explained where explanation is possible. It forms an interesting and well balanced account; and it may be read and appreciated with the help of a good atlas supplemented by the map contained in the book, which though small (1:2,000,000) is clear and uses the latest material.

In the second part Albania is described district by district; these being grouped into four larger regions: the Albanian lowland, widening southward to beyond the Semeni River; Albanian Epirus; Inner Albania, southern and northern, these last being clearly separated on most geographical grounds by a line from Elbasan to Dibra. This part does not make easy reading. It is very largely concerned with land forms, though other aspects are not neglected; consequently it could be fully appreciated only with the help of a good large-scale map or with good block diagrams. The author gives no diagrams, but a fair sample of the landscapes is shown in the sixteen excellent photographs. The existing Austrian map (1:200,000) is not based on surveys. However, we learn that a new map on the same scale is soon to be expected from Vienna. Again, the reader should have access to a geological map. Indeed, having regard to his text, the author ought to have included one in the book. And this leads to the chief matter for criticism.

On almost every page there are references to the character and age of the rocks and to their structure. There is frequent mention of recent dislocations, warpings, and "transverse disturbances," which are evidently of paramount importance. But neither the nature nor the distribution of these is comprehensively indicated. Much prominence is rightly given to the great through valleys all over the country, from the long and profound canyons like that of the Drin to short defiles, now dry, crossing single anticlinal ridges. These valleys are usually referred to as antecedent or epigenetic; and the reader naturally asks for information as to the drainage systems that made them. The author doubtless felt that pending further research he had better not try to satisfy our curiosity on this point. Near the end of the book (p. 147) he explains his reticence on a still more important matter; it would, however, have been as well to state at the outset that higher Albania is largely made up of great ancient surfaces of denudation of little relief that have been deeply trenched by new drainage systems, but that investigation has not yet proceeded far enough to correlate these surfaces either within Albania or with those of other parts of the Balkan Peninsula.

Dr. Louis has nevertheless performed an important service in the elucidation of the remarkable physiography of Albania by drawing attention to the occurrence and position of such features as these old surfaces, the mature but relict river systems upon them, the elbows of river capture, the through valleys, karst phenomena of various scales and stages, and glacial features, and by giving brief but vivid verbal pictures of each. In regard to the evidences of glaciation, special care has been exercised in noting the altitudes of cirques and moraines. These occur on nearly all the higher ranges. The Pleistocene snow line in Epirus near the coast (in latitude 40°) is placed at about 1800 meters (p. 99), and on the central massif of northern Albania at the same altitude (p. 134). In the latter area a mountain group, the Dyalitsa (east of the confluence of the Black and White Drins), nearly 2500 meters high, shows no clear evidence of glaciation, though elsewhere in the same district evidences are found above 2100 meters. It is suggested that the Dyalitsa has been considerably upheaved since the Ice Age; and the extreme youth of the profound (2000 meters) gorge of the Luma, which bisects the range, seems to support this view (p. 148).

This up-to-date work on the least-known country of Europe is most welcome, and it should be read not merely by those interested particularly in physiography. For the author is very precise and careful in his observations on the influence of climate, exposure, and soil upon the vegetation; and he gives many illustrations of the effects of these and of topography on the distribution and life of the Albanians.

Of the many fragments of human geography presented we may allude to two. First, that in general all plains of considerable size are in the hands of large propritors, such as the Bey families, and that the landless peasants there are economically and socially in a miserable position (p. 50). Yet such areas are capable of vastly increased production. Secondly, we have a picture of the secluded mountain trough of the upper Matí River—the Matya—as the home of the largest North-Albanian clan (about 24,000), a most independent sept, who play a very active part in national politics. This broad and well protected valley is the kernel of the Albanian Noble party, and feudalism persisted here till recently. Moreover, it is physically predestined for such a rôle. The Matí flows in a trench 200 meters deep, and its many affluents dissect the wide valley floor deeply, leaving plateau fragments to form the sites of numerous strongholds. Villages there are along the less broken fringes. But there is no town, and a centrally placed ford serves as site for a weekly market.

Alan G. Ogilvie

In French Africa

D. P. Barrows. **Berbers and Blacks: Impressions of Morocco, Timbuktu, and the Western Sudan.** The Century Company, New York and London, 1927. $3.00. 8 x 5½ inches.

While the author of this book is a student of political science, his book is chiefly noteworthy for its geographical content. His remarks upon French colonial administration in Algeria and Morocco, interesting and entertaining, are far surpassed by his observations on that part of the French African colonial empire bordering on the North Guinea coast, from Dakar by rail to the head of the Senegal Valley and down the Niger to Timbuktu, thence southeasterly to Bassam on the Ivory Coast. Professor Barrows traveled through a country inhabited by Mohammedans of various racial stocks, thence across the important dividing line between Mohammedans and fetish worshipers in the Sudan, from desert country through grassland and scrub and the edge of the forested belt, and finally through the heavy tropical forest of the coast. Here are geographical changes and human reactions to them of such a degree of interest as to tempt one to write indefinitely of interesting details. The Senegal River as a boundary between Berbers and Blacks, the rough line of the division of the Sudan at Lake Chad with constantly growing contrasts in density of population, mode of living, and political control and organization as one goes respectively east and west of the lake, the description of the bush at the edge of the Sudan as one passes through the zone of transition between grassland and forest, the vivid account of the salt caravans from Timbuktu to the salt mines of Taodéni—these are among the questions discussed with an eye to regional relationships rather than to the purely local details.

One is a little startled by the sentence on page 234: "There seems to be an instinctive movement of humanity toward the equator, away from the cold and toward the sun." While this is no doubt true of white and brown breeds in the part of black Africa which the author visited it would be more correct to say that the movement is in the nature of a minor current. Much larger currents of white stocks have moved progressively northward. The great empires, with their capital cities and commercial centers have had a far more conspicuous northing than the southing of the streams that Barrows describes in the Sudan. Recent southward movements in the Sudan have been accredited by many observers to increasing aridity of the desert border.

The observations in the field of political geography are valuable partly for the light they show upon French methods of administration in the great colonial realm from the Mediterranean to the Gulf of Guinea, and partly for the contrasts afforded in the methods of French and British administration of native peoples. Each makes use in its own way of native culture and social and political organization, the British more indirectly than the French and with more attention to control for trade than for the purpose of bringing about respect for superior organization, as in the case of the French. In the case of both French and British, economic benefits flow chiefly from the maintenance of public order, the suppression of the slave trade, and the general security of life that is brought about. The author compares French procedure with that of Imperial Rome in method but claims that it is just and beneficent beyond disproof. He concludes: "Nowhere in colonial life have the moral qualities of Europe been given finer emphasis than in the relations here established between the white and black races. The prospects of the Sudan rest entirely in the continuation of this authority." All this is written from the standpoint of superior race and culture and in defense of so-called imperialism; and there is undoubted strength on this side of the argument as well as on the other.

The Strait of Gibraltar

Otto Jessen. **Die Strasse von Gibraltar.** xii and 283 pp., maps, diagrs., ills., index. Dietrich Reimer, Berlin, 1927.

Two currents pass through the Strait of Gibraltar, an upper one flowing east and a lower one flowing west. The influence of the upper current is felt in a relatively lesser percentage of salt in the surface waters throughout the southern half of the Mediterranean almost as far as the Egyptian coast. Conversely, the influence of the lower current is felt in the Atlantic in a somewhat greater salinity of the waters at a depth of about a thousand meters throughout an area stretching as far west as the Azores and north nearly to the coast of Ireland. It is estimated that the upper current carries into the Mediterranean 46,041 cubic kilometers of Atlantic water each year and that the lower current carries out to the ocean 43,279 cubic kilometers of Mediterranean water. Were the sea floor of the Strait to be raised 100 meters, the annual excess of 2762 cubic kilometers passing eastward would be cut off, and in time the Mediterranean would dwindle to a group of salt lakes.

These facts and figures illustrate one of the far-reaching influences of the Strait of Gibraltar. No less significant has been the relation of this passageway to the distribution and movements of plants and animals. Although the Strait admits into the Mediterranean many oceanic animals, there are other marine forms "accustomed to cool depths far from the coast" which either cannot reach the inland sea because of its shallow entrance or are not adapted to survive in its warm waters. There are also forms, particularly among the mollusca, that are restricted to the Mediterranean. The near approach of Spain to the African coast has permitted the spread along the western margins of the Iberian Peninsula of a flora characteristic of Morocco and the Canary Islands. At the Strait two of the main routes of bird migration between Europe and Africa converge. On the other hand, the waterway has presented an almost absolute barrier against the passage of certain European mammals into Africa, and vice versa. No less significant has been the relation of the Strait to the advance of civilizations and the flow of commerce: since the early Paleolithic period it has served now as a bridge for and now as an obstacle in the way of movements of men and goods both north and south and east and west.

Dr. Jessen's scholarly and well-balanced study deals with the Strait and its adjacent shores not only in these larger relations but also as forming a geographical region of itself. The work is based partly on field investigations carried out in 1922 and 1924. More than half of the text is devoted to what the French conveniently term *géographie naturelle* (physical, plant, and animal geography); the remainder to human geography, much attention being given to the historical background. Dr. A. Schulten has contributed a chapter entitled "Die Säulen des Herakles," in which references and descriptions of the Pillars of Hercules in the works of the ancient geographers and historians are discussed (see *Geogr. Rev.*, Vol. 17, 1927, pp. 505–506).

Two particular points deserve special notice. In regard to the structural relations of the Strait, Jessen concurs with other recent geologists in the opinion that Eduard Suess's theory is no longer tenable. Suess conceived that the lines of Tertiary folding developed in the Betic Cordillera swing in an arc around the westernmost gulf of the Mediterranean (Gulf of Alboran) and are continued in the mountains of the Riff. Jessen, however, shows that the strike of the Tertiary folds on both sides of the Strait is generally northeast-southwest rather than north-south. In his opinion the Betic Cordillera and Riff form the outer margins of one great orographic system, paralleling a sunken core now occupied by the Strait and perhaps continued southwestward under the Atlantic. However, "the meridional trend of the older layers binding the continents together at the Mediterranean end of the Straits and further north and south curving around in the form of an arc, is to be explained by the position of these layers at the western apex of a block that was arched up in late Mesozoic times and that later subsided beneath the sea." The Gulf of Alboran now fills the site of this sunken block, the north-south-trending strata being represented in Jebel Musa and the Rock of Gibraltar. (See, however, the criticism of this view in the *Geogr. Journ.*, Vol. 71, 1928, pp. 79–81.)

The second point of particular interest relates to Gibraltar. Jessen's discussion of the strategic, diplomatic, and commercial significance of Great Britain's crown colony is illuminating. The main value of Gibraltar no longer lies in the defensive strength of the Rock itself but rather in the harbor as a naval base dominating one of the world's most critical passageways. Against modern siege operations from the land Gibraltar would be helpless unless the British could hold the Spanish side of the Bay of Algeciras. It seems a pity that in a genuinely scientific work of this sort the author has deemed it advisable to close his discussion of Gibraltar—and with it the volume as a whole—by sounding a note of hostility to Great Britain.

The Oceanography of the Antarctic

Erich von Drygalski. **Ozean und Antarktis.** Maps, diagrs. (Deutsche Südpolar-Expedition, 1901–1903, Vol. 7, Part V, pp. 387–556.) Walter de Gruyter & Co., Berlin and Leipzig, 1926. 14 x 10½ inches.

K. Hessen. **Gezeiten- und strombeobachtungen auf der Winterstation des "Gauss" 1902–03.** Map, diagrs., ill. (*Ibid.*, pp. 557–602.)

In these two publications, which appear some twenty years after the return of the expedition, the oceanographic results of the German South Polar Expedition in the *Gauss* are discussed in a comprehensive manner. Drygalski's paper consists of four chapters dealing respectively with the soundings, the surface waters, the subsurface waters, and the currents. Note must be made of the admirable arrangement of the paper. Each chapter begins with a discussion of the methods used in making the observations that form the subject matter of the chapter and of the accuracy attained; this is followed by a table listing the observational data; the concluding section is devoted to interpreting the data and relating them to the larger problems of oceanography.

Oceanographic observations—soundings, temperatures, densities, salinities—were made not only in the Antarctic waters but also all along the route of the *Gauss* both to and from its south polar station. In discussing the soundings made Drygalski relates them to the general problem of the relief of the ocean floor. In the discussion of the surface waters, he points out that for the sea the non-periodic variations constitute a more important characteristic then the periodic variations, since the causes of the latter reside within the atmosphere, while the causes of the former lie within the sea itself. He therefore gives tabular values of the non-periodic daily fluctuations observed; and on the basis of these observations he summarizes the characteristics of the circulation in the different oceanic areas traversed—the North Atlantic, South Atlantic, and South Indian.

In contrast to the non-periodic fluctuations which Drygalski emphasizes as characteristic for the surface waters, he stresses, in his discussion of the subsurface waters, the importance of mean values, since fluctuations of all kinds become less and less sharply defined with increasing depth. The involved relation between the upper layer of the water, the bottom layer, and the middle layer are here elucidated. In discussing the currents Drygalski distinguishes between purely surface drifts which vary with the winds and the more deep-seated currents to which subsurface currents belong. A section of this chapter is devoted to the chemical, geological, and biological features of currents, in which the gas content of the waters, the character of the bottom, and the plankton are discussed. A short appendix gives the results of wave observations. While the *Gauss* observations made two decades earlier furnish the quantitative basic data of the paper, the discussion is in the light of recent oceanographic knowledge. The publication therefore not only constitutes a primary source of information for the oceanography of the Antarctic but furnishes at the same time an important contribution to the larger problems of the sea.

Hessen's paper deals with a more restricted field of inquiry, namely, the tidal movements at the *Gauss* winter station in the Antarctic. In February, 1902, the vessel became ice-bound off Posadowsky Bay (lat. 66° S., long. 89½° E.). Beginning in June hourly heights of the tide were observed continuously for a period of six months. During this period a number of current observations were also made. Information with regard to tides and currents in the Antarctic is so very meager that for this reason alone these observations are of importance; but additional interest attaches to them because they were made at some distance from the land. At the point where the *Gauss* became ice-bound the nearest coast is about 60 miles distant and the sea somewhat over 1200 feet in depth.

The tide observations were analyzed both harmonically and non-harmonically. The results show the tide here to be of the mixed type, that is one in which morning and afternoon tides differ considerably. The mean range of the tide was found to be just under two feet, the spring range two and a half feet, and the neap range a little over one foot. The relation of the change in sea level to change in barometric pressure was investigated and found to be as 1:12, which accords very well with the ratio demanded by theory. The current observations are of particular interest in two respects. In the first place they were found to be rotary counterclockwise which strengthens Sverdrup's theory with regard to rotary currents; and in the second place the wind current was found to deviate to the left of the wind, which is in agreement with Ekman's theory of wind-driven currents.

H. A. MARMER

THREE STUDIES OF SETTLEMENTS

MARIA RECKNAGEL. **Die Städte und Märkte des Bayerischen Donaugebiets.** Maps, ills., bibliogr., index. *Mitt. Geogr. Gesell in München*, Vol. 20, 1927, No. 1, pp. 3–118.

EDUARD IMHOF. **Siedelungsgrundriss-Formen und ihre Generalisierung im Kartenbilde.** Maps, ills., bibliogr. *Mitt. Geogr.-Ethnogr. Gesell. Zürich*, Vol. 24, 1923–24, pp. 5–60.

JOSEPH GANTNER. **Die Schweizer Stadt.** 179 pp.; diagr., ills., bibliogr., indexes. R. Piper & Co., Munich, 1925. M. 6. 9 x 6 inches.

These three studies of settlements, chiefly towns, are listed in the above order because the first-named is concerned primarily with the country and the situation of the towns and their functions; the second discusses the form of the town and its representation on the map; the third makes an attempt to get an inkling of the minds that sought satisfaction in the outlines and silhouettes of the historic towns of Switzerland.

The Bavarian Danube basin is a very well marked region of agriculture little modified by industry; it is therefore rather poor in towns of any size but has many little market towns or villages, distant perhaps a dozen kilometers from one another. They tend to be at nodes of communication, and their development seems to belong to the thirteenth and fourteenth centuries, when in this region agriculture was feeling the need of centers of exchange. The town population, even including very small towns, is not more than one-third of the whole, and some of the towns, like Augsburg and Regensburg, increased in size rather because they were connected with long-distance traffic than because of local or even regional needs. In the Württemberg portion of the region the town population is a larger proportion of the whole, and there is more industry. In the Franconian region there is still more industry, and the towns are older with market places formed from a square or large space rather than by a mere street enlargement. In the latter region, too, there are many pygmy cities, the results of an exaggerated fashion of city foundation in the Middle Ages. The result is most beautiful, as all will agree who have seen Rothenburg ob der Tauber or Dinkelsbühl.

The mapping of a town is said by Imhof to need special study in order to bring out the really genetic characters; and those who have studied many maps provided in atlases and guides will enthusiastically agree and may be encouraged to follow his arguments. He illustrates many of his points by examples of city growth along radii, with later filling of the intermediate sectors; and on the whole he chooses his examples well, save that in several cases he might have strengthened and expanded the interest of the study by references to French towns.

Gantner gives us what at first sight is a picture book, but on further study it is seen to be a fruit of much meditation and to need the same accompaniment for its proper appreciation. The author probably sacrifices a good deal by leaving out of consideration almost entirely the history of town life, in order that he may concentrate upon plans as developed by aerial photography and silhouettes such as one gets fine chances of studying in Switzerland; many a traveler will here think of Thun or Basel or of Gantner's beloved Bern. The Roman tradition is exemplified, sometimes from towns founded much later; the regularity-in-irregularity of many a medieval town is studied in examples; and much attention is given to the question of dominance of natural forms, such as hills, or of buildings, such as castles, while the streets and squares and fountains, the walls and gates and castles and churches all get treatment. The pictures are a joy, and if we might single one out it would be No. 64, of Rapperswil, a place of unique interest and romantic beauty of setting.

Gantner is evidently striving to apprehend the medieval mind, that sought satisfaction in a castle-crowned hill or in the setting of a great tower or spire on a height with street vistas up to it. The other writers are more content to set out for us what are fairly ordinary facts. None goes very deep into the idea of the city and the life it represents, and the student who knows France and Italy will be at once impressed with the many contrasts that may be worked out between those lands and Switzerland or Bavaria. The medieval market town of the inner parts of the Paris basin is very different from its German-Swiss cousin; but the clock or bell tower, for example, of many towns around the fringe of that basin is a feature that one very often finds in German Switzerland.

To go deeper into the matter of the town someone must try to weave together the threads of general and regional social history, of town geography, and of regional anthropology; for the characteristics of the people who made or extended the town matter almost as much as the situation in which it grew. It is a great task, but one for a traveling philosopher; and a geographer should try to be one if he can.

H. J. Fleure

CORRESPONDENCE

On the Northern Coast of Foxe Land

In connection with the geographical work of the Putnam Baffin Island Expedition (see *Geogr. Rev.*, Vol. 18, 1928, pp. 1–40) the Society sought to get in communication with Mr. George Dawson Howell, Jr., who made observations for the Carnegie Institution of Washington on the Macmillan Expedition of 1921–1922. In a letter dated November 26, 1927, Mr. Howell writes as follows:

You inquire as to my observations on the country about the following stations of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington occupied by me in 1921–1922:

Station	*Latitude*	*Longitude East of Greenwich*	*Date*
Baffin Island No. 3 (Noovookuok)	65° 23.9′N.	282° 27′	Jan. 5, 1922
Baffin Island No. 5	65° 24.4′N.	283° 19′	Apr. 4, 1922
Baffin Island No. 6	65° 19.9′N.	284° 16′	Apr. 8, 1922

Station No. 3 (Noovookuok) is about a quarter of a mile inland from the western shore of Fox Land and about four miles south of the northernmost point of Fox Land. Noovookuok (which means Big Needle) is a small, sharply-pointed cape jutting westerly. Four miles north of this station the coast runs in a general east-and-west direction. The elevation of this station is about 40′. The highest elevation on Noovookuok is about 100′, not more. South of here, along the western coast of Fox Land, the country is broken with low hills increasing in elevation as you go inland. This coast, in the winter I was there, was supporting eight families. The country around the Hudson Bay Post at Cape Dorset was supporting many more. The land is pretty well covered with caribou moss and lichen sometimes known as *tripe de roche*. There were very few caribou that winter, but there were tracks of a great many bears and plenty of white foxes.

I found a raised beach about three miles inland at an elevation of about 60′, considerably weathered. From Station No. 3 eastward the land flattens out. Offshore, as far as you could see from the highest elevation, lay the barricade ice, consisting of floes that are let down on the ground by the ebb tide and are milled up by the flood coming in and increasing to tremendous thickness.

The elevation of Station No. 5 was about 5′. Just to the westward were a few little humpy knolls and ridges of rock by the shore perhaps 25′ high at the maximum. At some points along this shore the ice foot ran out about a mile as smooth as a table, evidently left by the last spring tide; but from there out the barricade ice ran to the horizon.

Near Station No. 6 there are some broad low ridges (whose highest elevation I estimate at about 50′) rising to the east and north. This station was my farthest east. From the highest elevation I could see the shore stretching away in the far distance to the north. An Eskimo told me the previous winter that he had been up in the bay beyond as far as Kowalook [Koukjak], the outlet of Lake Netchling [Nettilling] and that the tide in the bottom of the bay came in faster than he was able to run. This sounds like a bore tide, and the indications of the barricade ice miles offshore make the statement plausible.

From Noovookuok to the eastward we saw no signs of bear or caribou. No Eskimos live in this part of the country at all.

Yours very truly,
George D. Howell, Jr.

University of Michigan, Ann Arbor,
December 14, 1927.

To the Editor:

Will you allow me to comment upon a book which is being widely read and which has already been reviewed in the October number of the *Geographical Review*? I refer to Mr. C. E. P. Brooks' "Climate Through the Ages" (Benn, London, 1926).

The main thesis of this book, as announced upon the front page, is that we may regard "genial conditions (of climate) as the normal state of affairs on this our earth, and the glacial periods as episodes disturbing the normal climate for a brief time, as at long intervals a passing cyclone disturbs the peaceful life of a tropical island."

The literature of the subject is given with much appearance of completeness, but, what is most remarkable, with no mention of the fact that the same thesis was promulgated with greater clearness a full sixteen years earlier in a joint paper by David White and F. H. Knowlton, two of the most eminent paleobotanists of our time (David White and F. H. Knowlton: Evidence of Paleobotany as to Geological Climate, *Science*, Vol. 31 (N. S.), 1910, p. 760). In this article the opening statement by White and Knowlton is "Relative uniformity, mildness (probably subtropical in degree), and comparative equability of climate, accompanied by a high humidity have prevailed over the greater part of the earth, extending to, or into, the polar circles during the greater part of geologic times since, at latest, the Middle Paleozoic. This is the regular, the ordinary, the normal, condition."

Dr. Charles Schuchert, a high authority on past climates, as early as 1914 dealt with the same subject from the point of view of past faunas (Charles Schuchert: Climates of Geologic Time, *Carnegie Instn. Publ. No. 192*, pp. 265–298, and *Ann. Rept. Smithsonian Instn. for 1914*, pp. 277–311); in the following year I stressed the relationship of these facts to the glacial anticyclones (*Proc. Second Pan-Amer. Sci. Congr.*, Washington, 1916, Sec. II, Vol. 2, pp. 184–187); and the late Dr. Knowlton in 1919 (Evolution of Geologic Climates, *Bull. Geol. Soc. of America*, Vol. 30, 1919, pp. 499–566) went so far as to say:

"It is perhaps not too much to say that it has now been demonstrated beyond reasonable question that climatic zoning such as we have had since the beginning of the Pleistocene did not obtain in the geologic ages prior to the Pleistocene. I think this statement of conditions is very generally accepted by geologists and paleontologists—in fact, I am at a loss to know how the data available can be otherwise interpreted."

While Knowlton's statement is undoubtedly true as it relates to specialists in his field, it is quite another matter as it relates to the general recognition of the facts and the use of them to modify existing theories built upon the diametrically opposite assumption, or in the making of new theories.

Modern geology has been largely built upon the thesis set up by Lyell that "the present is the key to the past"; but geologists are now beginning to realize that the present is but a brief and extremely abnormal period of earth history and that any attempt to use present rates of denudation or deposition as yardsticks for the measurement of past geologic history can lead only to error. Hence the great importance of a book like that of Brooks which presents the arguments in a forceful way for those who have not concerned themselves with this vastly important question.

Despite his failure to take account of the really important literature of his subject, which must take from him any claim to priority, Brooks has read most intelligently and presented very forcefully the material of those articles which are included in his bibliography. He seems to have a special gift for sifting out the essential as it relates to the problem under consideration.

W. H. Hobbs

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Travelers, men of science, and others properly accredited are welcome at the rooms of the Society and may freely use the book and map collections.

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OUR CONTRIBUTORS

Dr. Baker is an agricultural economist in the U. S. Department of Agriculture. With V. C. Finch he is the author of "Geography of the World's Agriculture" (1917). The "Atlas of American Agriculture" is being prepared under his supervision. Among numerous articles that he has contributed to periodicals reference may be made to "Land Utilization in the United States: Geographical Aspects of the Problem" (*Geogr. Rev.*, Vol. 13, 1923) and "Agriculture of the Great Plains Region" (*Annals Assn. of Amer. Geogrs.*, Vol. 13, 1923). Dr. Baker is a member of the Pioneer Belts Committee of the Social Science Research Council.

Dr. Orchard is assistant professor of economic geography in the School of Business, Columbia University. He has prepared a number of studies on the economics of the coal industry, including "The Rent of Mineral Lands" (1922) and "A Proposal for the Regulation of the Coal Industry" (1925), published in the *Quarterly Journal of Economics.* Under the auspices of the Council for Research in the Social Sciences of Columbia University he spent the year 1926–1927 in the Orient, investigating the development of manufacturing industries, especially in Japan and India.

Dr. Smith is a member of the department of geography at the University of Wisconsin who has this year (1927–1928) been filling a temporary vacancy at the Ohio State University. He has for a number of years been interested in population studies and their graphical presentation.

Professor Goldthwait is head of the department of geology at Dartmouth College and geologist of the New Hampshire State Highways Department. His work in the latter capacity has led to the study of various aspects of the human geography of the region in which the state lies, as for instance the population study "A Town That Has Gone Downhill," *Geographical Review*, October, 1927. He is the author of two excellent handbooks, "Physiography of Nova Scotia" (1925) and "Geology of New Hampshire" (1925).

Dr. Bretz is professor of geology in the University of Chicago. He has been interested for several years in the physiography, stratigraphy, and glacial history of the Pacific Northwest. A study devoted particularly to the bars of channeled scabland will appear shortly in the *Bulletin of the Geological Society of America.*

Professor Gautier, of the University of Algiers, is an authority on the geology and geography of northern Africa. He is the author of the excellent manual "Le Sahara" (1923); his most recent work "L'Islamisation de l'Afrique du Nord" (1928) is reviewed in this number of the *Geographical Review.* He has contributed several articles to the *Geographical Review*, including "The Ahaggar: Heart of the Sahara" (July, 1926).

Dr. Riso Patrón has been active for many years in exploration and geographical studies, especially in the Cordillera of the Andes. He was Chilean representative on the Chile-Argentina boundary dispute, and the Chilean commissions which surveyed the Chile-Argentina and Chile-Bolivia boundaries were under his charge. From 1905 to 1907 he was Director of the Oficina de Limités of Chile and from 1907 to 1914 Director of the Oficina de Mensura de Tierras. He edited the well-known map of Chile on the scale of 1:500,000, and his numerous works include the "Diccionario de Chile" (1924). In 1925 he received the David Livingstone Medal awarded by the American Geographical Society. He is now acting as Chief of the Chilean Section of the Special Commission on Boundaries, Tacna-Arica Arbitration.

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Oriental Explorations and Studies, Nos. 1–4. By ALOIS MUSIL. No. 1. **The Northern Hegaz: A Topographical Itinerary.** xii and 374 pp. 1926. $7.00; No. 2. **Arabia Deserta: A Topographical Itinerary.** xvii and 631 pp. 1927. $8.00; No. 3. **The Middle Euphrates: A Topographical Itinerary.** xv and 426 pp. 1927. $8.00; No. 4. **Palmyrena: A Topographical Itinerary.** xiv and 367 pp. 1928. $7.00. Each volume fully illustrated with photographs, maps, drawings, and plans.

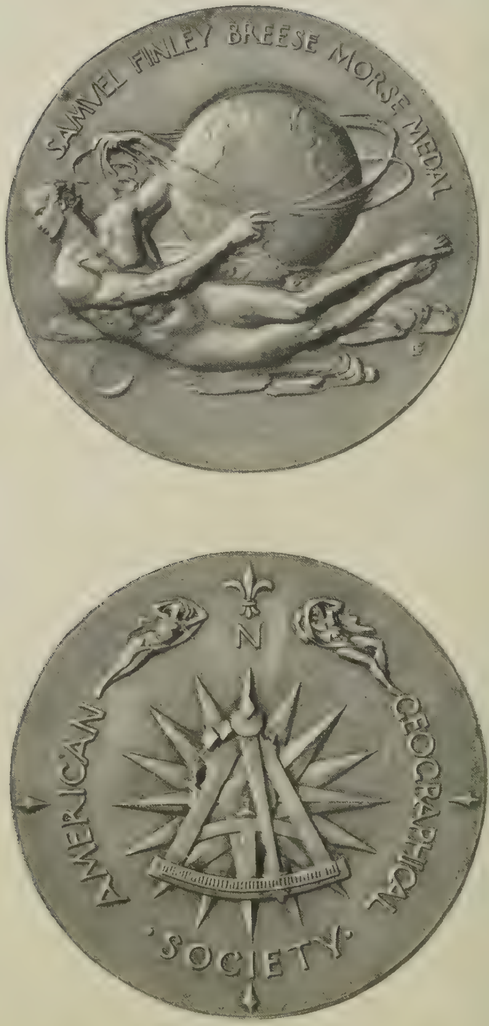
Geography of the Central Andes: A Handbook to Accompany the La Paz Sheet of the Map of South America on the Millionth Scale. By ALAN G. OGILVIE. With an introduction by ISAIAH BOWMAN. With 2 maps in color and 41 diagrams and photographs. 240 pp. *Map of Hispanic America, Publication No. 1*, 1922. $3.00 (if purchased with the La Paz map, $2.00).

Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, North H-11, **Baja California Norte**; North G-12, **Baja California Sur**; North F-16, **Yucatán**; North F-18, **Santiago de Cuba**; North E-18, **Kingston-Port-au-Prince**; North E-19, **Santo Domingo-San Juan**; North E-20, **Lesser Antilles North**; North D-20, **Lesser Antilles South**; North C-17, **Panamá**; North A-17, **Río Mira-Islas Galápagos**; South C-19, **Acre**; South D-19, **Puno-Río Beni**; South E-19, **La Paz**; South E-20, **Sucre**; South F-19, **Iquique**; South F-20, **Río Pilcomayo**; South G-19, **Atacama**; South I-18, **Canquenes y Islas Esporádicas**; South L-18, **Península de Tai-Tao**; South M-18, **Isla Wellington-Lago Argentino.** $2.00 each sheet.

Mapa de la Republica de Panama, 1:500,000 [7.89 miles to 1 inch] compiled from over 100 original surveys, many of them unpublished. Printed in five colors. Follows in general the scheme of the International Map of the World on the Millionth Scale, but hypsometric tints have been omitted and the provinces shown in color instead. Accepted as official map by the government of Panama. 33 x 63 inches. 1926. $3.00.

The Leardo Map of the World of 1452 or 1453. Colored reproduction (measuring 28⅝ x 23½ inches, printed on sheet 35 x 30 inches) of map in the collections of the American Geographical Society. Accompanied by volume containing text by JOHN KIRTLAND WRIGHT describing the original map and a note by A. B. HOEN on the method of reproduction, with 3 photographs and 7 maps, viii and 90 pp. *Library Series No. 4.* 1927. $15.00 ($2.00 for text alone).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.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THE
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POPULATION, FOOD SUPPLY, AND AMERICAN AGRICULTURE*

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U. S. Department of Agriculture

THE three principal centers of the world's population are southeastern Asia, Europe, and North America. The extent of the arable area, including both land in crops and that which it is physically possible to use for crops, in these three regions is similar in magnitude—in each a billion and a half acres, more or less. But southeastern Asia and adjacent lands (India, Siam and Indo-China, the East Indies, China and Japan) contain about 900 million people, or nearly half the population of the world; whereas Europe has only about 500 million, little more than a fourth of the world total; and North America has less than 150 million people, or only a twelfth of the world total. As a consequence, there is fully three times as much potentially arable land per person in North America as in Europe and about six times as much per person as in southeastern Asia.

But the population of North America is increasing at a more rapid rate than the population of Europe or southeastern Asia. If Mexico and Central America, for which reliable data are not available, be excluded, the population of North America is increasing at the rate of about 1.5 per cent a year, of which about 1.1 per cent is by natural increase and 0.4 per cent is by immigration. The population of Europe, excluding the U. S. S. R. (Russia), for which data over a sufficient period are unavailable, is increasing only about half as fast, or perhaps 0.75 per cent a year; while the population of southeastern Asia as a whole probably is not increasing at present—in fact, owing to the troublesome times in China, it may be decreasing.

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*An address before the joint session of the Farm Economic Association and the Rural Section of the American Sociological Society in Washington, December 29, 1927. Data on agricultural production revised and brought up to May 1, 1928.

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It is natural, therefore, that many people in Europe and a few in North America should see in southeastern Asia a vision of the future condition in their own continent and be troubled in mind, if not oppressed, by the thought of approaching population pressure, poverty, and weakness. Let us, therefore, consider the validity of this assumption that conditions in southeastern Asia with reference to population and agricultural production are prophetic of future conditions in North America. Although, as will appear later, we have grounds for optimism, we should also realize that our anticipations are based on a continuation of present trends and that, inasmuch as nothing in the modern world is certain except change, it is possible our calculations may prove to be mistaken.

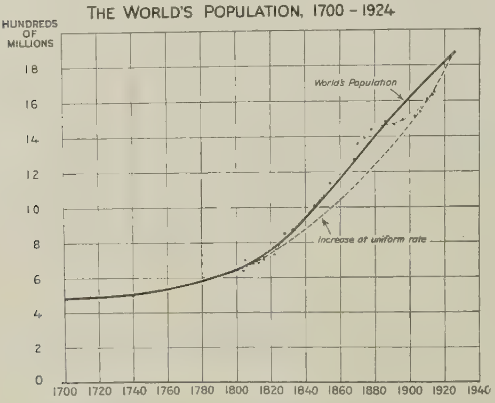

FIG. 1—The increase in the world's population since 1700, largely a result of the development of science and of economic organization. From G. H. Knibbs: The Mathematical Theory of Population, in Report on Australian Census of 1911, Vol. 1, Appendix A, Bureau of Census and Statistics, 1916.

Like all economic problems, this food problem has two sides, a demand side represented by population, and a supply side represented by agriculture. Let us consider the progress of population and then the progress of agriculture in each of the three continents after first noting the progress of population in the world as a whole.

THE PROGRESS OF POPULATION IN THE WORLD

The population of the world was about 500,000,000 in the year 1700, according to several estimates, 600,000,000 to 700,000,000 in the year 1800, about 1,000,000,000 in the year 1850, probably 1,500,000,000 by the year 1900, and is about 1,900,000,000 today. The population of the world has almost trebled since the year 1800 and prior to the World War was increasing at the rate of about 20 millions a year, which is an addition equivalent to the population of the United States every six years.

It appears, however, that a slackening in the rate of increase in the world's population is occurring (Fig. 1). This is owing primarily to the attainment of a stationary population in China a half century ago, if the official estimates may be accepted, and to a trend toward such a condition during the past two decades in India, which, however, may prove transient. Moreover, as population has increased in Europe and North America during the past quarter century or more, the rate of increase has lessened somewhat proportionately, so that the actual increase in numbers is now more or less stationary—about four millions a year in Europe and nearly two millions in North America.

The Progress of Population in the Orient

The rapid expansion in the world's population during the last two or three centuries attained momentum first, it appears, in southeastern Asia. According to the successive returns of the Chinese census given in a recent interpretation, the population of China in 1750 was about 180,000,000; by the year 1800 it had risen to 300,000,000; and by 1850 the advance was practically over, and the population had reached a stationary stage at about 425,000,000 (Fig. 2).[1] In 1923 the Post Office estimate, based on returns from district magistrates, was 428,000,000 for the 18 provinces of China proper, and about 440,000,000 for the entire Republic. A recent study by Professor Willcox, of Cornell University, based on Ambassador Rockhill's data and the discovery of a copy of the 1910 census, supports this evidence of a rapid increase in the population of China during the eighteenth and first half of the nineteenth centuries but indicates that the Chinese Post Office estimate of population at present is too high by probably more than 100,000,000.[2] If the Rockhill-Willcox estimate of about 300,000,000 people at present in China be accepted, or 315,000,000 with Manchuria and Sinkiang, and it was doubtless no greater 75 years ago, it would appear that the increase of population in China between 1750 and 1850 was of a similar magnitude to that in the United States between 1820 and 1920. Whichever estimate of China's present population be accepted, it is interesting to note that the population of China in the year 1750, according to the official returns, was only about 25 millions greater than that which the United States will reach about the year 1950 and was increasing at about the same rate as the increase in the United States today.

In India it is not possible to trace the progress of population so far back; but between the first census in 1871 and the fifth in 1911 British India gained 60 million people, which is considerably more than the increase in the United States during these forty years. The 1921 census, however, shows very little increase since 1911, either in British India or the native states. This is doubtless owing in large part to the epidemic of influenza in 1918, but it also appears probable that the population of India is approaching the saturation point under the present conditions of agricultural technique. However, the rapid expansion of manufacturing in India, as well as in other oriental countries, might extend the period of population increase for many years, provided food could be obtained to support the increase.

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[1] Chang-heng Chen: Changes in the Growth of China's Population in the Last 182 Years, *Chinese Econ. Journ.*, Vol. 1, 1927, pp. 59–69.

[2] Walter F. Willcox: The Population of China in 1910, *Journ. Amer. Statistical Assn.*, Vol. 23, 1928, pp. 18–30.

No positive statement as to the present status of China's population can be made. A study of selected rural groups made for "the normal year" of 1924–1925 suggests an increase, "which if continued would amount to a doubling of the population in every seventy years" (C. M. Chiao and J. Lossing Buck: The Composition and Growth of Rural Population Groups in China, *Chinese Econ. Journ.*, Vol. 2, 1928, pp. 219–235).

Agricultural Progress in the Orient

But in both India and China the increase in population has occurred without any marked advance in agricultural technique. The yield per acre of all the cereals is considerably lower in India than in the United States, and this is almost certainly true in China also, except for rice. There has been little development of dairying in either country, despite the fact that cattle have been raised for centuries; and, in general, the breeds of live stock are not as productive as in the United States. It appears probable that in both India and China the increase in population was accompanied by a lowering of the standard of living; although there is some evidence, notably the recent increasing per capita consumption of wheat, that the standard of living is rising in India at present.

Another surprising fact about China's agriculture (it is not true of India's agriculture) is that the proportion of the potentially arable land actually in crops is much smaller than in the United States. Of the 700 million acres, more or less, which it is physically possible to use for crops in China, only 180 to 200 million acres apparently were cultivated in 1918, according to official data,[3] or 25 to 30 per cent; whereas in the United States of the 975 million acres, more or less, which it is possible to use for crops, about 370 million acres, or nearly 40 per cent, were so used in 1919.

Probably two-thirds of the farmers of China are dependent on their own muscles for power, and apparently they can spade up or hoe up only two to four acres of land within the time permitted by the progress of the seasons. Experiments by men in the U. S. Department of Agriculture indicate that it takes 10 to 15 days to spade an acre. The cereals constitute about three-fourths of the total crop acreage in China. Two to four acres of grain does not yield sufficient food to support a family unless it is grown on productive land. There is a vast area of semiarid land in China, similar to the land in the western portions of our winter and spring wheat regions, but it cannot be utilized for lack of power. Whereas in western Kansas the crop area per farm averages 200 acres, yielding 1200 to 1400 bushels of wheat or equivalent, in northwestern China the average is only four acres of crops per farm. Even to spade or hoe up this acreage requires 40 to 60 days. At seven bushels of wheat per acre, only 28 bushels would be raised on the four acres, which, after allowing for seed, is scarcely enough to keep life in two people for a year. So crop production in China is found mostly in the valleys and on river deltas, where much of the land can be irrigated and where three times as much wheat per acre can be raised as on the less moist or less fertile uplands, or five times as much rice per acre, if the climate permits.

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[3] "Statistical Tables of Agriculture and Commerce, 1918," issued by the Department of Agriculture and Commerce, Peking, 1921. See also O. E. Baker: Agriculture and the Future of China, *Foreign Affairs*, Vol. 6, April, 1928, pp. 483–497.

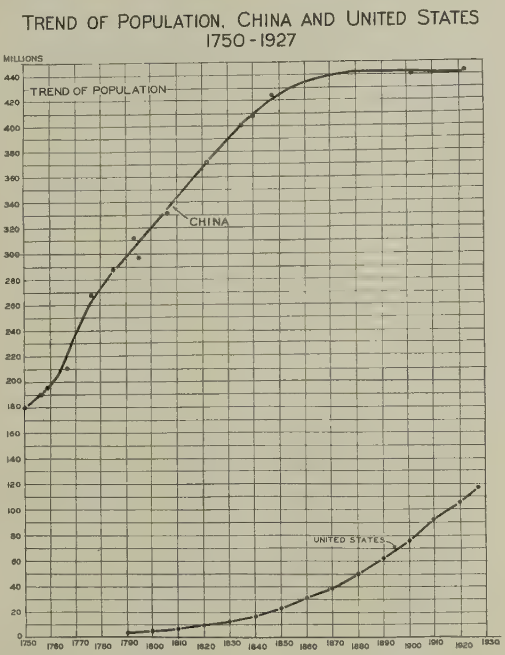

FIG. 2—Population trend in China and the United States compared. The data for China shown in the graph are from an article by Chang-heng Chen in the *Chinese Economic Journal*, January, 1927.

In Japan scientific technique and economic organization have supplemented the beneficent influence of a stable government, and as a consequence not only has population doubled in the past 50 years, but also the real income per capita has approximately doubled, according to a statement made to me at the Institute of Pacific Relations in Honolulu, July, 1927, by Dr. Nasu, Professor of Rural Economics in the University of Tokyo. However, despite the fact that Japanese farmers are even more dependent than Chinese on human muscle for power, fully three-fourths of their potentially arable land is in crops. This is owing partly to the humid climate, which provides sufficient moisture everywhere for high yields, and partly to the fact that Japanese farmers have available most of the assistance that modern science can afford. The agricultural experiment stations and other technical institutions are as highly developed in Japan as anywhere in the world. Partly as a consequence, the utilization of the agricultural resources has proceeded closer to the physical limit than elsewhere in the world probably, except Java; and Japan is facing the problem of population and food supply in all its stark severity.[4]

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[4] See "The Pressure of Population in Japan," by J. E. Orchard, pp. 374–401 of this *Review*.

THE POPULATION PROBLEM IN THE ORIENT

The Orient, therefore, does not seem to afford much help in finding a solution to the population problem. China might imitate Japan, further develop modern science and industry, and probably double its present population without diminishing the average individual's welfare, but this would only postpone for less than a century facing the fact of declining well-being. However, this development of modern science and industry in China is worth while promoting, and during the century a great change in social traditions and ideals might be achieved.

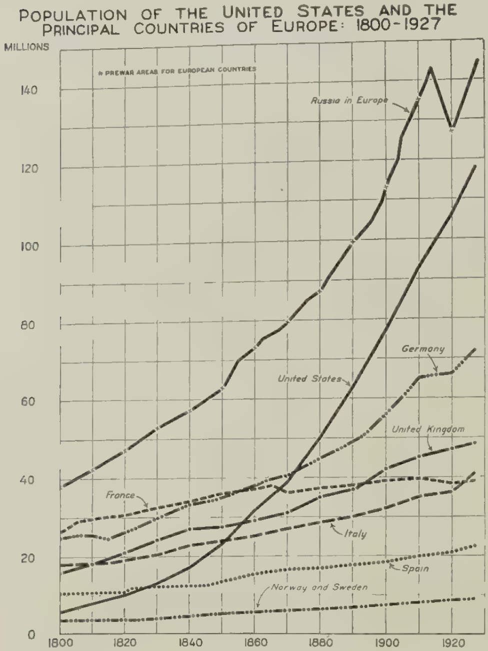

FIG. 3—Population trend in certain European countries and the United States compared. Data are from a graph in the United States Census 1910 (Vol. 1, p. 35), supplemented since 1910 by figures published in the Statesman's Yearbook.

From the standpoint of a permanent solution the depressing feature is that nowhere in the Orient does there seem to be an appreciable tendency toward voluntary restriction of population. Obviously, where there is no voluntary restriction there must be ultimately the involuntary restriction that Malthus described. Although in India the birth rate appears to be falling slightly, in Japan the birth rate was rising until last year and, apparently, is a third higher now than it was 50 years ago. However, the death rate has also increased so that the natural increase rate has risen from 7 per thousand to only 11 per thousand. For China no statistics are available, but it appears clear that the probably stationary population is owing to a high death rate, especially high among infants and the aged, and to wars, local famines, and occasional outbreaks of some pestilence.

THE PROGRESS OF POPULATION IN EUROPE

Let us now turn to Europe, especially to northwestern Europe. In 1750 the population of Europe was, possibly, 170 millions, or less than that of China. By the year 1800 the population had increased to about 200 millions, in 1850 it reached 280 millions, and by 1900 it was nearly 400 millions. During the past quarter century, despite the devastations of the World War, it has increased to 500 millions (Fig. 3).

This increase in population, unlike that in China and India, has been accomplished without a decrease in the standard of living; indeed, it appears probable that the per capita consumption of meat, of milk, of fruit, and of fresh vegetables, which are normally much more expensive than the cereal foods, has increased materially during the past century in most countries of western and central Europe, in some countries as much as 50 per cent.

How this extraordinary increase in both population and average well being was accomplished may be briefly noted with reference to England, though England, of course, was in advance of most of the Continent both in agricultural practice and in industrial development. In the year 1600 the population of England and Wales is thought to have been about 5,000,000; in 1700 about 5,500,000; in 1750 about 6,500,000; in 1800 about 8,900,000; whereas in 1901 it was 32,500,000 and today is over 39,000,000.

The Progress of Agriculture in Europe

We may review very briefly and in generalized fashion some of the important steps in the progress of production as a background to be kept in view when we note later the recent progress of agricultural production in both Europe and North America.

The increase of agricultural production in England and in most of northwestern Europe as well can be traced back, in large measure, to the spirit of individual inquiry, which led both to the Protestant Reformation and to the development of modern science. Even during the Middle Ages England afforded a haven for heretics from the Continent, many of whom were artisans. They established themselves usually in the towns and villages, where greater freedom to work and worship prevailed. As the towns grew the demand for food and raw materials grew also, and thus commercial agriculture arose. The profits derived from the sale of agricultural products promoted the development of private property in land, and this led to the Inclosure Acts. These Acts permitted the consolidation into a contiguous farm of many small parcels of land that had been operated previously only in unison with adjacent parcels farmed by other people and in accordance with tradition.[5]

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[5] This medieval communal cultivation of land is still the common practice in the U. S. S. R. (Russia) and is an important cause of the low crop yields per acre. The coöperative use of tractors and harvesting machinery on these communal fields, however, is opening the way for other improvements in farm practice that may be as revolutionary as those in England during the eighteenth century and earlier.

With individual control of farm operations thus secured both by landlords and freemen, the adoption of improved methods of production became possible. Turnips were introduced from Flanders and were grown on the fallow of the medieval three-field system. This intertilled crop was more effectual than the fallow in controlling weeds, and it increased the crop area by a half. Moreover, the turnips and other root crops provided feed for more live stock, and these produced more manure. During the eighteenth century also clover was introduced, and this crop added both humus and nitrogen to the soil. Whereas in England wheat yields during the Middle Ages did not average over ten bushels per acre, by the year 1800 Arthur Young estimated the yields at 20 bushels. During the first half of the nineteenth century the use of lime and later of nitrate, phosphate, and potash fertilizers became common, partly as a result of the work of Liebig in Germany and of Lawes and Gilbert in England. Principally because of the use of animal manures, clover, and mineral fertilizers, wheat yields in England had reached 30 bushels per acre before 1880. Meanwhile, the breeds of farm animals were greatly improved. The amount of meat or milk produced per unit of feed consumed doubtless gradually increased, and at the same time the quality of the product was improved.

During this first half of the nineteenth century also steamship and railroad locomotive opened up a new epoch in the world's agriculture. Prior to the coming of these modern means of transportation, agriculture had been confined very largely to the originally forested lands. The forests supplied fuel and building material, and the ever-running streams that are found in forest areas provided drink for man and beast. Most of the grasslands of Europe and Asia, as well as of North America, were grazing grounds for nomads—Hungarians and Tatars in southeastern Europe, Manchus and Mongols in eastern Asia, Indians and later cattlemen and sheepmen in western North America. Lack of wood and water prevented the utilization of these grasslands for agriculture and the civilization dependent on it.

In addition to the development of steamships and railroads, two other great inventions help to explain the agricultural development of these grasslands and the extraordinary increase of population and wealth in Europe which has followed—the invention of well-drilling appliances and the development of grain-harvesting and threshing machinery. Wells gave water to the almost streamless plains, grain-harvesting machinery enabled one man to do the work of five, releasing the other four for labor in urban industries, while the railroads brought wood and coal to the settlers and provided cheap and rapid transportation to market for their grain and other products.

Thus it appears that the advance of science and the resultant development of industry in northwestern Europe, by affording large markets for agricultural products and by providing means of transportation to those markets, has not only increased both the acreage and the acre yields of the crops in Europe but also has encouraged the expansion of crop production onto the grasslands of the world, until eastern Europe as well as western North America, even distant Argentina and far-away Australia and New Zealand, contribute to the food supply of western Europe. In the past this importation has been mostly from the former grasslands of the temperate zones, but in the future it must be more and more from the tropics.

Europe has much to teach North America with reference to a food supply for the increasing population, and it would appear that the limit of production has by no means been reached in Europe itself. The resources of science and agricultural technique are not exhausted.

These many means by which the food supply of western Europe has been increased are mentioned because some modern economists are prone to think only in the terms of the classical economists. When Malthus and Ricardo wrote their very influential treatises relating to population and the rent of land, the importance of nitrogen and phosphorus and potash in plant production was unknown, not a steamship rode the waves, not a railroad had been built, there was no agricultural machinery in our modern meaning of the word but only those farm implements that had been in common use since before the time of Christ. Milk production probably averaged not over 2000 pounds per cow, instead of 5000 pounds as in several countries of northwestern Europe and our best dairy states today. The point of diminishing returns was more or less fixed because farm practices were fixed, instead of being a point that receded with each advance in agricultural technique as is the case today. Those economists interpreted the economic conditions in their time; but it was a different time from that in which we live, though, perhaps, the difference is more in degree than in kind.

The Population Problem in Europe

In the trend of birth rates and death rates also Europe differs from Asia. In most countries of Europe a significant decline in the birth rate is in progress. Between the decades 1871–1880 and 1901–1910 the birth rate fell in Germany from 39 to 33 per thousand population, in Austria from 39 to 35, in Italy from 37 to 33, in Finland from 37 to 31, in Holland from 36 to 30, in England and Wales from 35 to 27, in Scandinavia from about 31 to 27, and in France from 25 to 20. In 1926 in England and Wales the birth rate was only 18 per thousand of population, dropping below that of France; and in Germany for several years it has been less than 20 per thousand, or about the same as in France; but, of course, owing to much lower death rates, the natural increase in these countries was much larger than in France. In Italy the decline in the birth rate has been greater in the past twenty years than in the previous thirty years. In Catholic as well as Protestant countries of Europe the birth rate is falling. The death rates have been falling about as rapidly, so that the rate of natural increase has remained stationary or changed only slightly. But the death rates cannot keep falling continuously; and, if the birth rates continue to decline, several other countries as well as France will approach a stationary population in a few decades. If Europe can maintain its present rate of increase of both agricultural and industrial production for a half century, the future is full of hope.

The Progress of Population in North America

Nowhere has population increased at a more rapid rate during the past century and a half than in the United States. When our nation declared its independence 152 years ago, there were about 2,500,000 people scattered along the Atlantic Coast from Georgia to Maine. A quarter century later, by the year 1800, population had more than doubled; in a half century, by the year 1825, it had quadrupled; and by 1850 it was nine times as large as in 1775. Until the Civil War, Malthus' statement that, given plenty of food and normal freedom from disease, population tends to increase in geometrical ratio held true. But in the next quarter century a decline occurred in the rate of increase—a greater decline than can be explained by the influence of the Civil War. Population had not doubled by 1875, and between 1875 and 1900 it increased only 73 per cent. From 1900 to 1925 the increase in population was only 50 per cent, and it is now increasing at the arithmetical ratio of about 1,700,000 each year. This growth of the American nation from 2,500,000 to about 119,000,000 people during the period of slightly more than a century and a half since the Declaration of Independence, with the accompanying increase in wealth and culture, is unparalleled in human history.

But the rate of increase is decreasing. Both birth rates and death rates are falling. However, the death rate, which is now about 11.5 per thousand in the registration area, cannot go much lower, and may become higher. Dividing 1000 by 11.5 gives an average age of nearly 90 years, which is far beyond the present average or the average that may ever be expected. It is obvious that this "crude" death rate is not indicative of the "expectation of life," and is so low partly because of an abnormally large number of young people in our population. However, a five-year-old child may now expect to live to well past 60. Dublin and Lotka have shown that after the present natural increase rate in the United States, about ten per thousand, is corrected for the larger proportion of young people in the population at present than there will be in the future, resulting from the fact that the population is increasing at a less rapid rate than in the past and that the large number of immigrants till recently were mostly young people, also because of the decreasing proportion of the population which is rural, the natural rate of increase would be reduced to one-half, or to about five per thousand.[6] Moreover, the trend in this rate almost certainly will be downward. It appears not improbable that the population of the United States will reach a stationary stage of 200 million near the year 2000 A. D.[7] Automobiles and other luxuries are only too successfully competing with children as objects worthy of sacrifice; and, perhaps, in more cases a proper sense of parental responsibility for the education of the children accomplishes the same result.

The trend of population in Canada, though the figures are much smaller, shows a similar but less regular rate of increase. The population in the year 1800 was about 400,000; by 1825 it had doubled; and in 1850 it was nearly six times as great as in 1800. From 1850 to 1875 it increased only about 35 per cent, and the increase was about the same percentage between 1875 and 1900. From 1900 to 1925, owing principally to the settlement of the Prairie Provinces, the increase was about 75 per cent. But between 1921 and 1926 the population in the Prairie Provinces increased only about one per cent a year, and the number of farms decreased.

Progress of Agricultural Production in the United States

Has agricultural production in the United States kept pace with this extraordinary increase in population, especially since the fertile western prairies have been occupied and settlement has pressed beyond onto the semiarid lands of the Great Plains region? It has, viewing the period as a whole. After falling behind during nearly two decades after the year 1900, agricultural production since the World War has increased more rapidly than population. And can agricultural production continue to keep pace with the increase of population until this population of 200,000,000 is reached? Available evidence indicates that it can, though probably a slight change in diet will occur, involving less meat and more dairy products and cereals.

Recently the Division of Land Economics, of the Bureau of Agricultural Economics, has been preparing an index of agricultural production in an effort to understand the present anomalous agricultural situation and determine whether there is likely to be need of more crop land in the near future. The index consists of the annual amount of animal products (beef and veal, pork and lard, mutton and lamb, poultry and eggs, milk, wool and mohair), plus the production of that portion of some 28 crops which was not fed to live stock in the United States. The various items have been combined on the basis of the average farm price during the decade 1917–1926. An index of consumption of agricultural products also is being compiled, but the work is not as far along as that on the production index.

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[6] Louis I. Dublin: The Statistician and the Population Problem, *Journ. Amer. Statistical Assn.*, Vol. 20 (N. S.), 1925, pp. 1–12.

[7] This is the estimate of Professors Pearl and Reed, of Johns Hopkins University, made several years ago (compare Figure 5 in O. E. Baker: Land Utilization in the United States: Geographical Aspects of the Problem, *Geogr. Rev.*, Vol. 13, 1923, pp. 1–26). Professor P. K. Whelpton, of the Scripps Foundation for Research in Population, Miami University, in discussing this paper noted that the recent studies made by this Foundation indicated that a stationary population of 175 to 180 millions would be reached several decades before the year 2000 A. D.

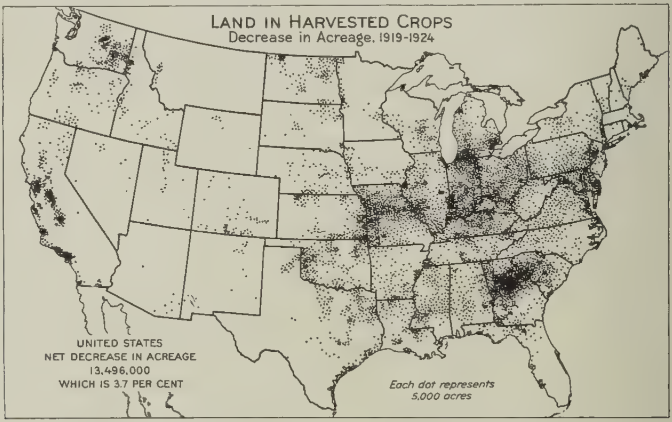

FIG. 4—The decrease in acreage of crops between 1919 and 1924 was general in most of the eastern, originally-forested portion of the United States, in general less fertile than the prairie and plains land and in parts too hilly to be well adapted to the use of modern farm machinery. With rising wages it has become increasingly difficult to farm some of these eastern lands profitably. Scale approximately 1:50,000,000. (Bureau of Agricultural Economics.)

It has proved possible to extend the production index only as far back as the year 1897 with a reasonable degree of confidence, because of lack of adequate data on animal products; but the index of crop production, the prices of agricultural commodities, and the volume of agricultural exports all indicate that agricultural production was increasing more rapidly than population after the Civil War and until near the beginning of the twentieth century.

AGRICULTURAL PRODUCTION SINCE 1900

The preliminary figures of this index indicate that the production of milk, of pork and lard, and of potatoes, fruits, and vegetables in the United States per capita of the total population was higher in the last five-year period, 1922–1926, than in the first five-year period, 1897–1901, or, except for potatoes, in any five-year period intervening.[8]

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[8] Bulletins giving details will be published by the Department of Agriculture when the index data are in final form. These will be illustrated by graphs.

On the other hand, the per capita production of the following foods decreased; beef and veal combined (beef decreased and veal increased), mutton and lamb combined (mutton decreased and lamb increased), chickens and eggs combined (eggs only slightly), and, notably, wheat and corn used for human food.

With reference to animal products, the per capita production of milk, which was about an eighth greater in the period 1922–1926 than in 1897–1901, was balanced by the decrease in per capita production of meat and the slightly smaller decrease in per capita production of poultry and eggs. The per capita production of wool declined much more, indeed, the production during the period 1922–1926 averaged about the same as in 1897–1901; but meanwhile population increased 50 per cent. With reference to plant products, the per capita production of wheat, and also the aggregate of other cereal products used for human food, was nearly a third smaller in the later than in the earlier period. On the other hand, the per capita production of potatoes and likewise of other vegetables was nearly a fourth greater in the period 1922–1926 than in the period 1897–1901; and the per capita production of the fruits was apparently a fifth greater. The per capita production of cotton during the past decade has been much less than during the previous 15 years but nevertheless was higher in 1925 and 1926 than in any year since 1914. Combining the various agricultural products, it appears that production per capita during the period 1922–1926 was slightly less than during the period 1897–1901.

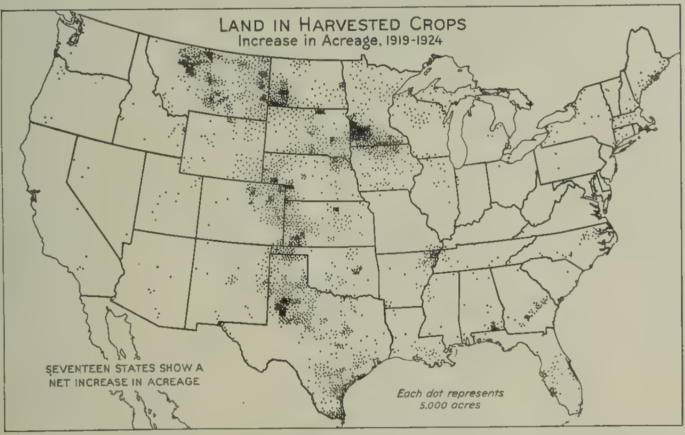
LAND IN HARVESTED CROPS
Increase in Acreage, 1919-1924
SEVENTEEN STATES SHOW A NET INCREASE IN ACREAGE
Each dot represents 5.000 acres

FIG. 5—The increase in crop acreage harvested in 1924, as compared with 1919, occurred mostly in the level, prairie portions of the United States, where, despite the subhumid to semiarid climate and low prices for farm products, the use of modern machinery, by increasing the area a man can cultivate, has made crop production profitable. (Bureau of Agricultural Economics.)

This comparison of the first and the last five-year period during the thirty years since 1897 is not adequate, indeed may be misleading, for between these two periods a notable depression in agricultural

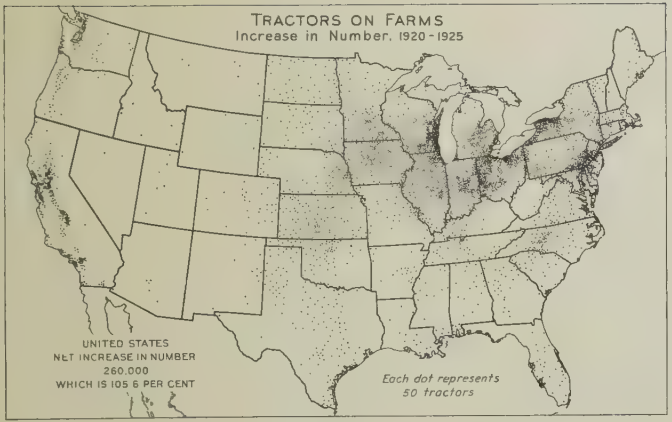

Fig. 6

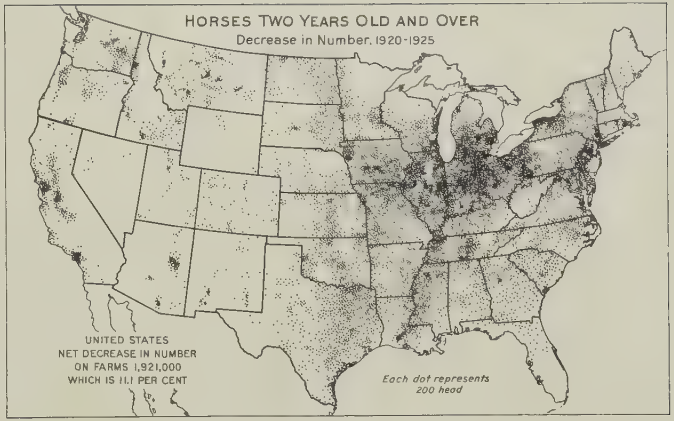

Fig. 7

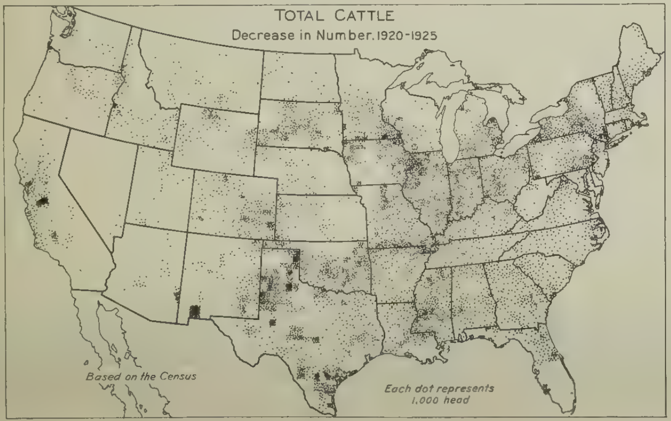

Fig. 8

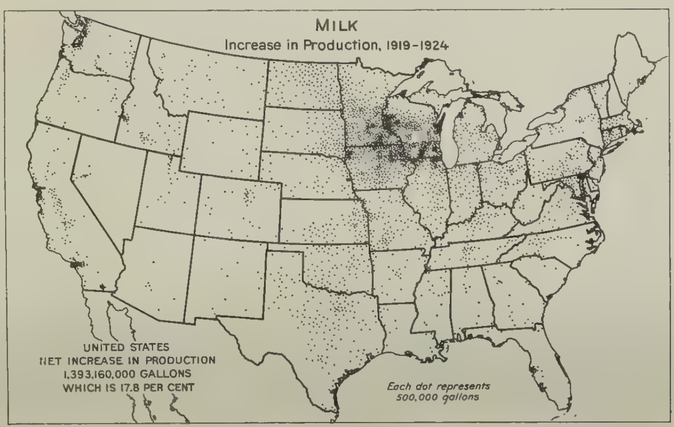

Fig. 9

Figs. 6 and 7 Cartograms showing the relation between increase in tractors and decrease in horses (1920–1925). (Bureau of Agricultural Economics.)

Figs. 8 and 9—Cartograms showing decrease in cattle (1920–1925) and increase in milk production (1919–1924). Despite the decrease in number of cattle in all the important dairy states except Kansas, Nebraska, North Dakota, and Montana, the production of milk was much greater in 1924 than in 1919. (Bureau of Agricultural Economics.)

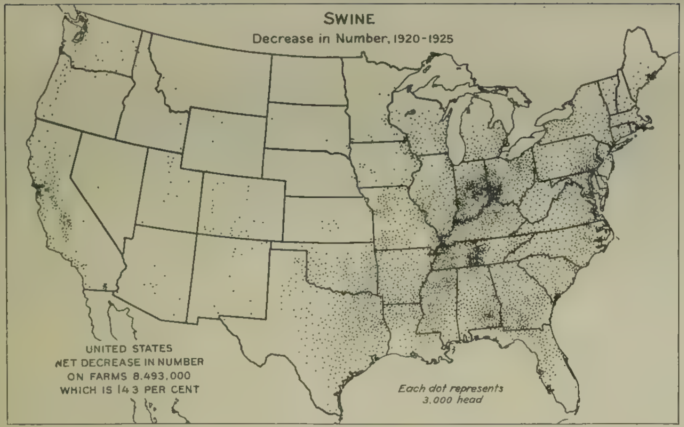

FIG. 10

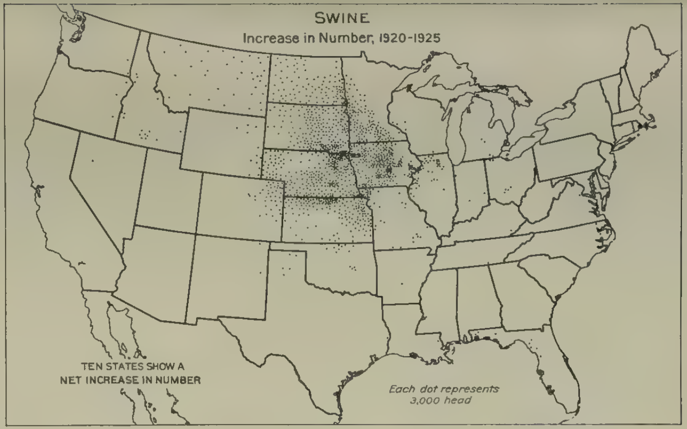

FIG. 11

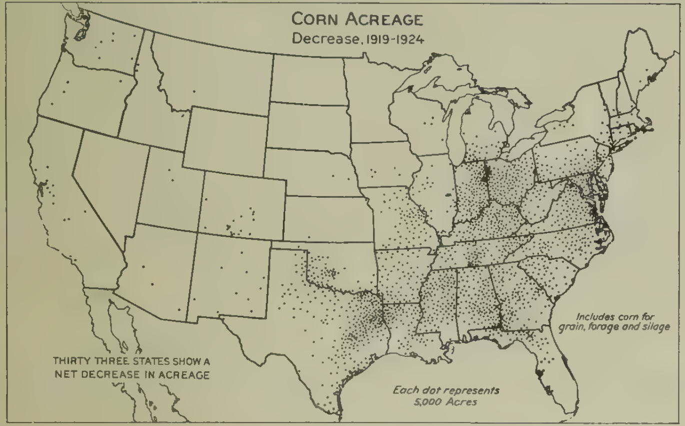

FIG. 12

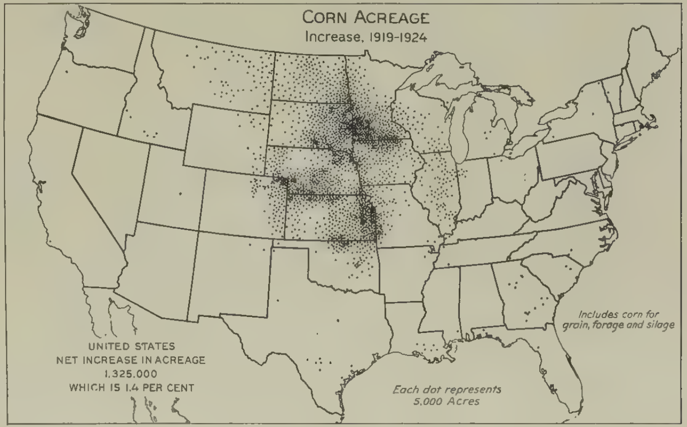

FIG. 13

FIGS. 10-13—Cartograms showing the relation between change in corn acreage (1919-1924) and numbers of swine (1920-1925). (Bureau of Agricultural Economics.)

production per capita occurred. During the period 1902–1906 agricultural production per capita was several per cent less than in the period 1897–1901; in the period 1907–1911 it was still less; in the period 1912–1916 it was about the same as in the preceding five-year period; and in the war and early post-war years 1917–1921 it declined to about nine-tenths of the per capita production in the period 1897–1901. Beginning with 1922 the increase in production has been rapid and almost uninterrupted. In the year 1926, for the first time since 1904, the average per capita production of agricultural commodities exceeded that during the period 1897–1901. Data are not yet available for 1927.

AGRICULTURAL PRODUCTION SINCE THE WORLD WAR

It appears that the slower increase of agricultural production than of population after the year 1900, notably during the period 1909–1917, consisted, in large part, of a retarded increase in animal products, notably beef, mutton, and wool. There was also a relatively small production of cotton during the years 1915–1923. Even less increase in production of wheat and other cereals used for human food had occurred. Largely because of this slower increase of agricultural production than of population a rise in price of agricultural products occurred, which was further augmented by the demands of the world war, and, as a consequence, the application of scientific research to agriculture has been stimulated, improved farm practices have been widely adopted, and agricultural production has recently increased to such an extent that it has overtaken the increase of population. Even before this point was reached, the increasing production, in connection with decreasing exports of wheat and pork and increasing imports of sugar, was sufficient to produce the troublesome post-war surplus.

Agricultural production as a whole was over 14 per cent greater in the period 1922–1926 than in the period 1917–1921, whereas population increased less than nine per cent between the midyears of these two five-year periods; in other words, the increase of agricultural production was over 50 per cent greater than the increase of population.

More surprising than this rapid increase in production and resultant surplus, however, is the fact that this condition has developed despite a decreased, or at least stationary, acreage of crop land. The census of 1925 shows a decrease of about 13,000,000 acres in the area of crops harvested between 1919 and 1924 (Figs. 4 and 5), the first decrease shown by any census in our national history; while the average of the estimates of the Division of Crop and Livestock Estimates for the five-year period 1917–1921 as compared with 1922–1926 indicates a decrease of 1,000,000 acres. Moreover, the acreage of pasture in farms has decreased (but not total pasture), and the number of horses and cattle and hogs has decreased notably; indeed, beef cattle are less numerous than at any time during the past 40 years, and there are about the same number of hogs in the United States as 40 years ago (Figs. 7, 8, 10, 11). Furthermore, the number of farms has decreased since the World War years, the farm population and number of farm laborers has decreased even more, and the average acre yield of the crops has increased only slightly.

This increase in agricultural production since the World War, despite a decrease in crop land and in number of live stock on farms, is owing primarily: (1) to the release for other uses of 15 to 20 million acres of crop land formerly required to feed the horses and mules which have been replaced by tractors and automobiles (Fig. 6); (2) to increasing efficiency of production, especially in the amount of milk and meat produced per unit of feed consumed; and (3) to a shift from the less productive classes of animals per unit of feed consumed toward the more productive (i. e. from beef cattle to dairy cattle and swine) and from the less productive crops per acre toward the more productive (i. e. less wheat and more corn in the North, less corn and more cotton in the South, and more vegetables and fruit, especially in California and Florida).

The Increase in Animal Products

About two-thirds of the increase in agricultural production is assignable to the increase of animal products. A study of available data indicates that there were about four per cent more dairy cows and heifers on farms January 1 in the period 1922–1926 than in the period 1917–1921 but that probably 20 per cent more milk was produced; that there were about five per cent fewer cattle but that six or seven per cent more beef and veal were slaughtered. However, after allowance is made for the depletion in number of beef cattle, there is no indication of a notable increase in production of beef and veal per animal on farms January 1. With hogs, however, as with dairy cows, the increase in production per head has been very large. There were about the same average number of hogs on farms January 1 in the period 1922–1926 as in the period 1917–1921, according to the estimates of the Bureau of Agricultural Economics, but the increase in pork and lard under Federal inspected slaughter was 25 per cent. Undoubtedly the inspected slaughter of hogs has constituted a larger proportion of the total slaughter in recent years, so that the increase in total production of pork and lard has been considerably less. It was about 20 per cent, according to the estimates of the Bureau of Animal Industry. There were somewhat fewer sheep on farms and ranges in the period 1922–1926 than in the period 1917–1921; nevertheless, over ten per cent more mutton and lamb was produced. Increase in production per animal is, of course, greater than increase in production per unit of feed consumed; but, after allowance is made for the feed released by the decrease in horses and mules and for the shift from the less productive beef cattle toward the more productive dairy cattle and swine, it appears that the production of animal products in relation to feed consumed by the animals increased about seven per cent between these two five-year periods.

Many factors have contributed to this increase in production of animal products per unit of feed consumed. One of the most important has been the more rapid mechanization of agriculture and decrease in horses and mules in the Northern and Western States than in the Southern States. The large increase in feed available for meat and milk animals in the Corn Belt and in the states to the north and west has resulted in a much smaller decrease in cattle in these states than in the South and in a notable increase in number of hogs in most of these Northern and Western States as contrasted with a very great decrease in the South (Figs. 10–13). In general, the cattle and hogs are much more productive both per head and per unit of feed consumed in the North and West than in the South, and as the acre yields of the feed crops are also much higher there has resulted not only an increased production of meat and milk in the United States per unit of feed consumed, but also an even greater increase of production per acre of crop land.

Another, and perhaps almost as important, cause of the increase in animal products per unit of food consumed has been the slaughter at an earlier age. Younger animals make more rapid gains on the same amount of feed than older animals. Deaths from disease also have diminished, particularly in the case of hogs, owing to better sanitation and fewer losses from hog cholera. Better feeding, especially the greater use of legumes, has been another factor. But probably as important as anything has been the wider distribution of superior stock. High producing animals reduce the amount of feed as well as labor per unit of product. It requires only about 50 per cent more labor to care for a dairy cow giving 10,000 pounds of milk a year than to care for a cow giving 5000 pounds, and the amount of feed consumed by the more productive cow is only about 50 per cent greater, according to 100,000 cow-testing records compiled by the Bureau of Dairy Industry. However, it would be fairer to compare high producing herds with low producing herds, and when this is done it appears that the increased production per unit of feed will not exceed 25 per cent.

Probably no more significant development is occurring in American agriculture than this increasing efficiency of meat and milk animals in transforming feed into food. Of the 16 per cent increase in production of animal products between the five-year periods, 1917–1921 and 1922–1926, indicated by the estimates of the Department of Agriculture, about two-fifths is assignable to the feed released by the decline in number of horses and mules, less than one-fifth to the shift from the less productive animals toward the more productive (from beef cattle toward dairy cattle and hogs), and fully two-fifths to the production by each class of animal of more human food per unit of feed consumed.[9]

CHANGES IN CROP PRODUCTION

Similar changes have occurred in crop production, but they are not of so great magnitude from the standpoint of economy in use of the land. Comparing the period 1917–1921 with that of 1922–1926, total crop production (including crops fed to live stock) increased about five per cent, while the aggregate acreage of the crops decreased slightly. However, only about one-third of this increase of five per cent in production per acre is owing to higher acre yields of the several crops, two-thirds being due to shifts from less productive to more productive crops per acre. In the Cotton Belt, for instance, except in Georgia and South Carolina, there has been a notable shift from corn to cotton, which yields a much higher value per acre. In the western Corn Belt and in the spring wheat region there has occurred a marked shift since the war from wheat to corn, which has a higher acre value (Fig. 13); and in California and Florida especially there has been a large increase in the acreage of fruits and vegetables, which have a very high value per acre.

CHANGES IN PRODUCTION PER MAN SINCE THE WAR

As the quantity of labor engaged in agriculture decreased probably between two and six per cent, it appears that there was an increase of between seven and eleven per cent in crop production per unit of labor available. It is probable that the real increase in efficiency was much greater than this and that some labor formerly devoted to crop production has been required to produce the large increase in animal products. Recalling the net increase in agricultural production of over 14 per cent and estimating the decrease in labor on farms at four per cent, it appears that between the period 1917–1921 and the period 1922–1926 agricultural production increased about 18 per cent per unit of labor employed.

This probably unprecedented increase in labor efficiency is owing not only to more productive live stock and crops but also to the use of more power on farms. The number of horses and mules two years old and over on farms decreased from 21,873,000 on January 1, 1920, to 20,619,000 on January 1, 1925; but during these five years the number of tractors on farms increased from 246,000 to 506,000. These 260,000 additional tractors had a rated tractive horse power of probably 3,000,000, to which perhaps 4,000,000 more horse power should be added for the increase in auto trucks and 2,000,000 horse power for the increase in stationary gas engines and electric motors on farms—in all, an increase of about 9,000,000 horse power of mechanical origin, not including any increase in automobiles.[10] Although this figure cannot be compared directly with the 1,250,000 decrease in horses and mules, it seems safe to say that in this five-year period there was several times as much increase in mechanical horse power on farms as there was decrease in animal horse power.

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[9] These proportions are based on preliminary estimates and are only approximate. The method of estimating will be described in a bulletin, now in preparation, on changes in land utilization since the World War.

Looking Ahead

The substitution of mechanical for animal power on farms must continue for several years at least, for the number of horses and mules being raised on farms are sufficient to replace only about half the horses and mules that die annually. In addition, it should be recalled that cost-of-production surveys indicate that somewhat higher acre yields of the crops will be profitable even at present prices. The wider use of highly efficient farm animals probably would be even more profitable. If only 50 per cent more feed is consumed by cows giving 10,000 pounds of milk a year than by those giving 5000 pounds, or even if the increase is only 20 or 25 per cent when the entire herds are compared, the possibility of a large increase in production of milk without any increase in crop acreage or in yields per acre becomes apparent. A similar, though probably smaller, increase in efficiency of swine, of sheep, and of poultry is in progress and will doubtless continue for several years at least. These and many other improvements in agricultural production that are taking place indicate that crop acreage is likely to expand very slowly, perhaps not at all, in the next few years.

Looking forward a century, when it appears likely that our population will have become stationary, all the evidence available suggests that agricultural production can keep pace with the increase of people without much greater change in the character of the food supply than that which has occurred during the past century. Doubtless there will be some decrease in the per capita consumption of meat, especially beef, accompanied, probably, by a corresponding increase in consumption of milk, cereals, vegetables, and fruits; but this will be merely an adjustment to an urban manner of life by an increasing number of people, such as has been in progress for several decades.

This confidence, however, in the capacity of American agriculture to increase the food supply as rapidly as population increases during the next century assumes that the advance of scientific knowledge, in experiment stations and elsewhere, and the spirit of progress among farmers will continue; also that at least the present degree of general intelligence among urban dwellers will be maintained. Should these bases of our civilization be impaired, agricultural progress might cease and population proliferate, as it has in the Orient, until poverty and ignorance overwhelmed our nation also.

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[10] C. D. Kinsman: An Appraisal of Power Used on Farms in the United States, *U. S. Dept. of Agric. Bull. No. 1348*, 1926, p. 6 (data used in graph). The figure on horse power developed by tractors has been reduced below that given in this bulletin; also the estimates for increase in stationary gas engines and electric motors on farms are smaller than those in the bulletin.

In conclusion, may we note one other observation. Certainly so far as North America is concerned, and less certainly with reference to Europe, the progress of agricultural science and practice, in association with the decreasing birth rate, is removing much popular misapprehension with reference to the food supply as a cause of war. Such misapprehension is based on the reading of ancient rather than of modern history. "What achievement of our mechanical and industrial age is more distinctive than that it has relegated food, i. e. food as nourishment, to a subordinate place among the objects for which men labor."[11] Although this is not true of many peoples of the world, it is true of nearly all those who have applied science to agriculture and have entered the industrial age.

The future food supply of the American people seems assured, both with regard to quantity and variety, for at least a century, probably permanently; and, if the present trends in agricultural production and population in Europe continue, that continent, it would seem, need not be anxious, provided commerce is carried on with the rest of the world. The per capita consumption of food in the United States, and probably in Canada also, was never so high as at present, both with respect to quality and variety; and in Europe it is now approaching the unprecedented standards attained just before the World War. The prospect in the Orient is less promising, but the possibilities of increase in agricultural production are still great, notably in China. In Japan, the only Oriental country for which such information is available, the standard of living has risen greatly during the past fifty years, and it is to be hoped that the rest of the world will help rather than hinder Japan in its development of manufacturing, through which alone, apparently, it can continue to raise the standard of living of its people.

War offers no solution to the problems of increasing population but, instead, accentuates the difficulty. The solution, in the future as in the past, will be found in the progress of science and its application to agriculture, industry, and transportation and in the lowering birth rate which accompanies the scientific and humanitarian attitude toward life.

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[11] Mark Jefferson: Looking Back at Malthus, *Geogr. Rev.*, Vol. 15, 1925, pp. 177–189; reference on p. 184.

THE PRESSURE OF POPULATION IN JAPAN*

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JAPAN labors with a perplexing problem. Her population is increasing at a rate so rapid that it threatens soon to pass beyond the productive capacity of the nation's soil and resources. Pressure of the population on subsistence is the basis of the present economic unrest within the country. Search for relief is the keynote of Japan's domestic and foreign politics.

Increase in population is not a new phenomenon in Japan. There has been a remarkable growth since the beginning of the modern era, but in the earlier years the increase was no cause for alarm. It was regarded with approval as an evidence of a strong nation, and only within recent months has it become a matter of concern. In 1925 the population of Japan, exclusive of possessions, totaled approximately 59,700,000, and for that year the net increase was some 875,000. The present interest in the population question may be said to date from the announcement of that startling increase by the Bureau of the Census in the summer of 1926. For 1926 the increase was over 900,000, and monthly figures now available indicate that for 1927 it was nearly one million.[1] Japan's population is growing in absolute numbers and at a rate of increase surpassed only by the phenomenal growth in the United States, a country with an area twenty times greater than the area of Japan and with a large annual influx of immigrants.

No other problem is commanding so close or so general attention in Japan today. It has become an effective issue in the making and unmaking of Cabinets. Former governments have extolled in patriotic utterances the rapid growth of the population as a sign of national strength. The present government is seeking the means of providing for the greater numbers. The Imperial Government has created a Commission for the Investigation of the Problems of Population and the Food Supply, while several similar bodies are engaged in other studies related to productivity, natural resources, commerce and industry, and the like. Interest in the whole question of population has extended to the people. Scarcely a newspaper or a periodical appears anywhere in Japan that does not contain some mention of population and food supply.

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* This paper is a part of a study on the development of manufacturing industries of Japan that is being made under the auspices of the Council for Research in the Social Sciences of Columbia University. It is based on an examination of Japanese records and on an investigation carried on by the author and by Dorothy J. Orchard in Japan in 1926.

[1] The principal statistical sources used in this paper are: *Résumé Statistique de l'Empire du Japon*, Vols. 40 and 41, Tokyo, 1926 and 1927; Statistics of Agriculture and Forestry (in Japanese); and of Agriculture and Commerce (in Japanese); the Japan Year Book, 1926; official announcements as published in contemporary numbers of the *Trans-Pacific*, Tokyo; correspondence with the Statistics Bureau of the Imperial Cabinet regarding population estimates.

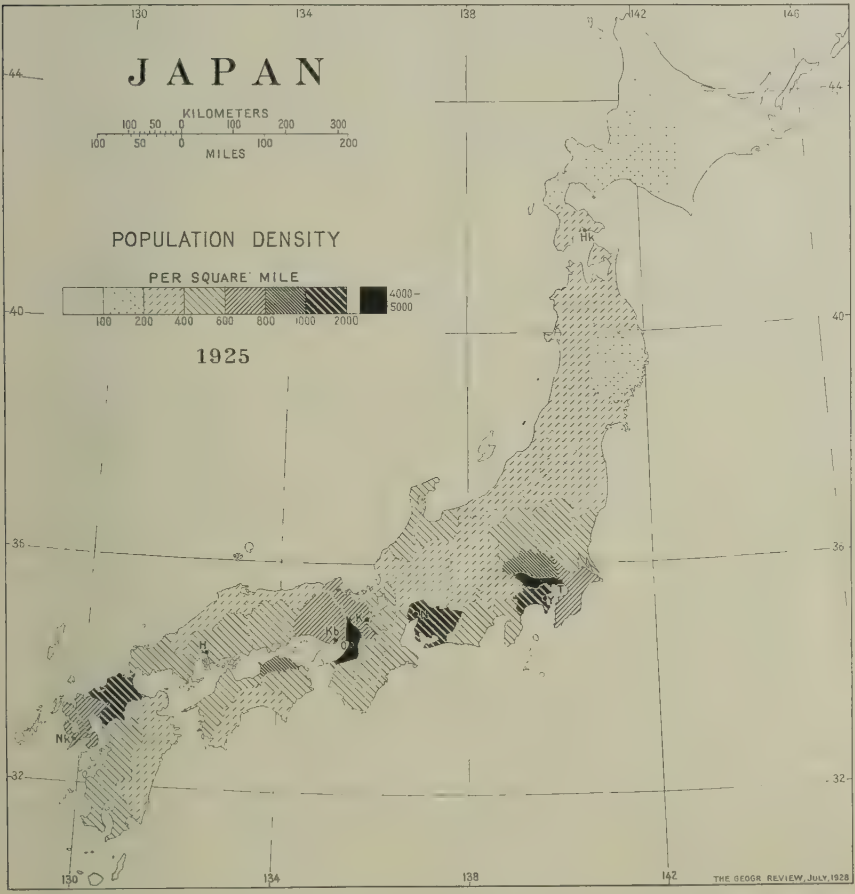

FIG. 1—Population density of Japan by prefectures, 1925. Scale approximately 1:14,500,000. The largest cities are indicated by initial letters: O, Osaka; T, Tokyo; N, Nagoya; K, Kyoto; Kb, Kobe; Y, Yokohama; H, Hiroshima; Nk, Nagasaki; Hk, Hakodate.

Such concern on the part of government and people can perhaps be best understood by expressing the population increase in terms of food. Rice is the staple food of Japan, and for many years the per capita consumption has been approximately 5½ bushels. To grow the five and a half million bushels of rice required for an annual population increase of one million about 145,000 acres of land must be added each year to the existing rice land. Such an area may seem small to Americans only one generation removed from the days of free land in the Middle West, but for the past 18 years the annual increase in rice land in Japan has been only from 25,000 to 35,000 acres. To meet this new pressure on food supply, Japan must annually bring under cultivation an area of new land four to six times greater than the area she has been able to make arable in any past year by the expenditure of the most arduous labor. Japan has no frontier of empty lands easily available for the taking. If production is to be increased, cultivation must climb higher up the mountain sides, steeper slopes must be terraced, farm land must be pushed farther into the sea, swamps reclaimed, new irrigation systems built, or greater yields forced from the soil—always in the face of greater and greater obstacles.

The Historical Background of the Population Growth

The growth of population in Japan is apparently one of the results of the opening of the country to western influence. At least, it had its beginning with that event. Since 1860 the population has doubled. For perhaps two centuries before that date it had remained practically stationary (see Fig. 2). It is not easy to understand why the ending of Japanese seclusion should so directly affect the population growth. The usual and seemingly obvious explanation must be dismissed. The introduction of western hygiene and medical science has brought no decline in the death rate. It is higher now than it was in 1870.

The Static Population of the Tokugawa Period

When Commodore Perry led his four vessels into Uraga Bay in 1853, he unwittingly hastened the close of a great period in Japanese history, the period of the supremacy of the Tokugawa shoguns, a supremacy that had its beginning in the opening years of the seventeenth century.[2] From the twelfth century Japan had been torn by internal wars. The country was divided among great feudal barons or daimyos, and they were continually at war with one another. Under the Tokugawas the supremacy of the shogun was established. The feudal lords were subdued, and the civil wars came to an end. Very shortly the country entered on its period of seclusion. Foreigners were expelled, and contact with the rest of the world was limited to a closely supervised trade with the Dutch and Chinese. The Japanese were not allowed to leave the islands. With the removal of the likely causes of either internal or external disputes, there began an era of peace that was to continue without a break for two centuries and a half. No other nation has ever enjoyed so prolonged a freedom from both domestic and foreign warfare. It might seem to be a period favoring a great growth of population, but certainly for the last century and a half of the Tokugawa rule, the only years for which statistics are available, and probably for the entire period, the population was stationary.[3]

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[2] The historical discussion that follows is based in part on "A History of Japan" by James Murdoch in three volumes: Vol. 1, 1910; Vol. 2, 1903; Vol. 3, 1926. For a more detailed account the reader is referred to that work, especially to Vol. 3.

The first general census was taken in 1721, and it was decreed that beginning with 1726 there should be a census every six years. The data are admittedly incomplete but they serve as an index of the population growth. In 1721 the registered population, without any correction for probable omissions, was a little over 26 millions. A century and a quarter later, in 1846, it was 26,900,000. The high and low points for the 125 years were separated by only two million, a marked contrast to the present annual increase of approximately one million.

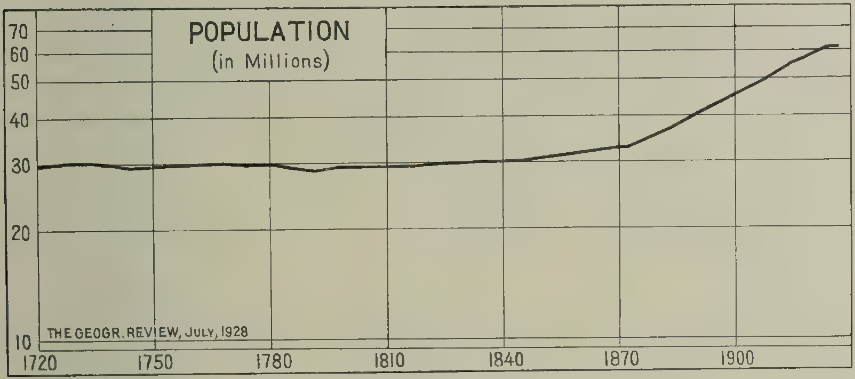

FIG. 2—Graph showing the contrast between the static condition of the population of Japan during the Tokugawa period and the rapid increase of modern times. (Graph on semi-logarithmic scale.)

FAMINES OF THE TOKUGAWA PERIOD

The Tokugawa era was a period of famines, and famines are a severer check on population than are wars. In the 150 years between 1690 and 1840 there were twenty-two famines in Japan, of which eleven were very destructive of life, one of the most serious occurring as late as 1837. The famines of China and India do not exceed in their horrors some of the Japanese famines in this period.

The famines were caused by flood and drought, frosts and typhoons, volcanic eruptions, and insect pests; but their severity and the great suffering and loss of life were due to the disorganization of the country and to the maladministration of the rulers. The Tokugawas had created a political empire, but the country was still economically a number of distinct states. Land transportation was little developed and limited to pack horses or to man-drawn vehicles over poor roads. Effective use was not made of the seacoasts and waterways; for, in order to keep the Japanese within the country, sea-going vessels had been destroyed and the building of boats above 50 tons capacity, later increased to 100 tons, had been prohibited. The rivers of Japan are short and turbulent and not well adapted to traffic. Goods, if permitted by the daimyos to cross their boundaries, were subject to heavy dues. With the exception of the great cities, which drained the rest of the empire for their support, each district had to be practically self-sufficient. In the event of famine there was little possibility of assistance from more fortunate districts.

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[3] Garrett Droppers: The Population of Japan in the Tokugawa Period, *Trans. Asiatic Soc. of Japan*, Vol. 22, 1894, pp. 253–284.

The country as a whole was in much the same situation. Japan's trade with the outside world was restricted to a few commodities of small bulk and high value. Rice could not be brought in from China or southeastern Asia to relieve a shortage. Japan was an isolated country made up of isolated units, and the country or the unit prospered or starved according to the local yield of the land.

Because of the division into isolated units there could be no regional specialization in production. Whatever the topography or the climate or the soil, food was necessarily the first consideration of agriculture. Though natural conditions might be much more suitable for tea or mulberry, neither of those crops provided subsistence in time of shortage, and there was no market for a surplus. Their production was not important even though the shogunate had exempted from taxation lands so planted.

The caste system that flourished under the Tokugawas, though borrowed from China at a much earlier period, reflected the local nature of production. The all-important personage in the economy of the people was the farmer, for from him came food and all wealth. To him was assigned a position high in the social scale immediately beneath the warrior class—the daimyos and samurai. The merchant received scant recognition. Trade was insignificant, and he seemed to contribute little. In times of famine he might even become the oppressor of the people, for he sometimes held back rice in order to secure higher prices. His was the lowest class, beneath the artisans and above only the outcasts.

Poor Administration of the Country

Economic disorganization of the country was not alone responsible for the severity of the famines. Even if transport had been easily available, there would have been no reserves in most of this period to send to the stricken areas. Some of the shoguns made provision for the storage of rice in the plentiful years against the coming of calamity; and Yoshimune, the eighth shogun, was able to save many lives during the famine of 1732 by sending rice from his granaries along the Sumida River in Tokyo to Kyushu and Shikoku. But later shoguns gave little attention to the welfare of their people. The stores of rice were dissipated by corruption or drawn upon to pay feudal dues, and very shortly the stocks built by Yoshimune were depleted and never replenished. Japan during most of the Tokugawa period suffered from poor government centered in the corrupt and extravagant court of the shogun.

Low Birth Rate of Tokugawa Period

Not only was the death rate very high during the Tokugawa period, but the birth rate was kept low by a number of checks. Although there was extravagance and profligacy at the courts of shogun and emperor, the upper classes, or samurai, seem to have lived for the most part frugal, stoical lives. Their income, fixed in rice, fluctuated in value with fluctuations in price. They engaged in no productive occupation and could not add to their incomes. They lived as parasites on the labor of the farmers, giving in return no measure of service, for in a land of peace their swords were no longer needed. Their profession was a closed one, since they were an obsolete heritage of the previous period of war, and new samurai were rarely created. By law the number of family heads was limited, and the first son inherited his father's position as well as his income and property. Among the samurai, to have more than three children was degrading. They rarely married before the age of thirty, but earlier marriages were usual among the common people.

Abortion and infanticide were practiced in all levels of society.[4] It is said that in the Ekoin Temple near the end of the Ryogoku Bridge in the Honjo district of Tokyo there is a tombstone which bears on one side in Chinese characters the inscription "Embryos' Tomb" and on the other the following: "This tombstone is built on the 28th day of the Fifth Month of the Fifth Year of Kansei [1793] for the spirits of about 10,000 embryos buried here." The Japanese word for infanticide is "mabiki," the same word used to describe the thinning of a field of vegetables.[5] Similar to the practice of infanticide was that of doing away with the aged. Near the city of Nagano there stands in the midst of the magnificent rice terraces a large rock where, according to local tradition, the old women of the valley were exposed to die after they had passed beyond their years of usefulness.

The Hampering Restrictions of Feudalism

These positive checks on the population were due for the most part to the scarcity of the food supply. Japan was dependent almost entirely upon agriculture, but the mountainous character of the islands made cultivation difficult. The arable area during the Tokugawa era certainly did not exceed 13 per cent of the whole and for much of the period it was probably nearer to 8 per cent.[6] The productive capacity of the land was less hampered, however, by the limitations of nature than it was by the restricting regulations of the feudal system.

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[4] K. Yamamoto: Birth Control in Old Japan, *Trans-Pacific*, April 2, 1927, Tokyo.

[5] Eijiro Honjo: The Agrarian Problem in the Tokugawa Régime, *Kyoto Univ. Econ. Rev.*, Vol. I. 1926, pp. 75–93.

All classes were surrounded and bound down by the most exacting rules. The rigid caste system arranged the population in water-tight compartments, and the son had little choice but to follow in the footsteps of the father; and in professions where there was no expansion there was always overcrowding. To prevent the growth of a class of large landed proprietors, a possible source of danger to the shoguns, it was decreed that the peasants could not sell their lands.[7] Though the law probably had the desired effect, it also kept good land in the hands of indifferent cultivators. It even resulted in the abandonment of land by some owners who dared to ignore the laws and seek other occupations. The peasant could not change the character of the use of his land. He could not reclaim new land without first receiving permission from the head of his village.[8] Taxes were heavy, and there was little stimulus to a greater production since a larger output usually led to heavier exactions by the tax gatherer.

The feudal laws and the restrictions on internal and external trade also discouraged the growth of manufacturing. Manufacturing was still in the handicraft, household stage; but it could have been developed to yield a considerable product for exchange. As it was, industry was restricted to supplying the needs of the immediate locality, and even that limited market was greatly reduced by the many sumptuary laws. They forbade the wearing of silk except by the highest classes. They regulated the size and construction of the dwellings, the number of presents that might be given at weddings and births. Manufacturing was as much on a subsistence level as was agriculture.

Growth of Population with Opening of Japan

Such was the Japan of the end of the Tokugawa era—a country static in population, stagnant in agriculture and in industry. Contrary to the beliefs of most economists the arrested growth was not due to exhaustion of agricultural possibilities. The point of population saturation had not been reached, but the country had developed to the utmost limits of the inelastic economic and political system of the feudal age. Further expansion was possible only with the bursting and casting off of the constricting shell. The opening of Japan to the West accomplished just that.

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[6] James Murdoch: A History of Japan, Vol. 3, The Tokugawa Epoch, 1652–1868, London, 1926, p. 353. Also Kan-ichi Asakawa: Notes on Village Government in Japan After 1600, II, *Journ. Amer. Oriental Soc.*, Vol. 31, 1911, pp. 151–216; reference on p. 159.

[7] Japanese Feudal Laws (a translation of "Edict in 100 Articles" of text given in Kodai-Hoten), *Trans. Asiatic Soc. of Japan*, Vol. 41, Part V, 1913. Also Asakawa, *op. cit.* Some Japanese authorities seem to believe that the purpose of this regulation was to protect the peasants from the loss of their lands. Whatever its purpose the effect on production would be much the same.

[8] D. B. Simmons and J. H. Wigmore: Notes on Land Tenure and Local Institutions in Old Japan, *Trans. Asiatic Soc. of Japan*, Vol. 19, 1891, pp. 37–270. Also Asakawa, *op. cit.*

Almost immediately upon the defeat of the shogun and the restoration of the emperor to power increase in population began. The first estimate of the population since the restoration of the emperor was made in 1872. It was an estimate more accurate and more complete than the censuses under the shoguns, and to be comparable the returns of the Tokugawa period must be corrected by adding approximately three million to allow for the classes not counted. In 1872 the population was 33 million, or an increase over 1850 of perhaps 3 million. The more rapid increase began in 1875. In the next five years, though it was the period of the Satsuma rebellion, there was an increase of 2 million, or at the rate of 12.43 per thousand per year. By 1889 the total was 40 million, and twenty years later the 50-million mark was passed. Since 1910, with the exception of the two years 1918 and 1919, the rate of increase has been from 12 to 15 per thousand per year, and the present absolute increase is approximately a million.

NO DECLINE IN DEATH RATE

It has already been observed that the great increase in population is not due to a lowering of the death rate through the introduction of Occidental sanitation and science. Famine has disappeared as a cause of death, but the present death rate is apparently no lower than it was in the non-famine years of the Tokugawa era. In 1873 the death rate was 19.6 per thousand. Fifty years later it was 22.8 per thousand. During the half century it ranged most of the time between 19 and 22 per thousand with a low point of 16.6 per thousand in 1880 and a high point of 26.8 in 1918.

Japan has never been subject to great plagues save that since the coming of the foreigner cholera has occurred in some of the ports; but there have always been present a great many intestinal diseases due probably to the diet and to the use of human excreta as manure for the rice fields. Neither the diet nor the method of fertilizing the land has changed with westernization. If anything, the chances of intestinal diseases have been increased, for with a greater population there are greater chances of contamination. At present, diseases of the stomach and intestines are the most common causes of death.

The growth of industry and the urbanization of the population have caused in some countries an increase in the death rate. Most of the Japanese cities have developed since 1875, and now some 35 per cent of the population live in communities of over 10,000. In 1889 only 15 per cent were urban.[9] The large cities, however, have a death rate lower than the average for all of Japan or for the rural areas. In 1925, for example, the death rate for Japan was 20.3 per thousand. For Tokyo it was 16.6 and for Osaka 19 per thousand. The purely agricultural prefectures of Toyama and Ishikawa had death rates around 25 per thousand.[10]

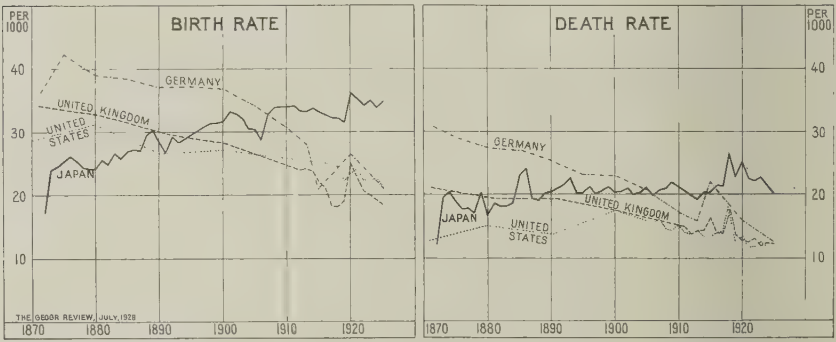

FIG. 3—Comparison of the birth rates and death rates of Japan and certain Occidental countries. Data from official sources.

INCREASE IN THE BIRTH RATE

The cause of the growth of population in Japan since the beginning of the Meiji era is to be found in a birth rate that now exceeds the birth rate of any of the other great nations, with the possible exception of Russia. In 1872 the birth rate was 17 per thousand; in 1924 it was almost double that rate, or 33.8. The vital statistics of Japan present some rather marked contrasts with the statistics of the leading western nations (see Fig. 3). In Japan alone has the curve of birth rates shown a general rising tendency; in the United States, the United Kingdom, and Germany during the past fifty years it has steadily declined. Despite their declining birth rate, however, the population of the three western nations has increased because their death rate has also declined. Japan has accomplished her phenomenal increase not by the conservation of life but through an amazing fertility. The high birth rate has in fact contributed to the death rate, for in 1924 almost 40 per cent of the deaths occurred in children under four years of age.

The great increase in the birth rate was due, in part, to the change in the attitude of the nation towards the size of the family that occurred with the opening to the West. The Japanese leaders decided that a large population—man power—was essential for defense and for aggression if that should ever become necessary. There began an active propaganda to establish the idea that a large family was the patriotic duty of every loyal subject of the emperor and that an increasing population was a sign of national strength. So successful has the propaganda been and so firmly has the idea of an increasing population been fixed in the Japanese mind that to one not familiar with the nation's history before 1850 it might seem to be an integral part of the Japanese religion, a heritage of former centuries. To all excepting the most liberal-minded the large family has become a sacred institution, and any attack upon it is almost as profane as an attack upon the emperor himself.

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[9] K. Yamamoto: Birth Control in Old Japan, Statement by Professor Ueda of Commercial College of Tokyo, *Trans-Pacific*, April 2, 1927.

[10] *Kampo*, September 1, 1926 (Official Bulletin of Japanese Government, in Japanese).

Increase in Food Supply through Trade and Improved Land Utilization

This philosophy of the large family, no matter how vigorously disseminated, could probably have never obtained so firm a hold on popular thinking if, at the same time, there had not been made available more abundant means of feeding the greater numbers. Rapidly as the population has grown, increase of the food supply has more than kept pace with it. During the modern period there has been no recurrence of famine and, according to Professor Morimoto, an economist of the Hokkaido Imperial University and an authority on the Japanese standard of living, the standard has advanced materially during the last half a century. As evidence he cites the increase in the per capita consumption of meat and sugar. The consumption of rice has also increased. In 1924 the consumption was 1.126 koku per capita as compared with 1.013 koku for 1835, an increase of about 11 per cent.[11] Almost half of this increase has occurred since 1912.

The resumption of trade with the outside world made it possible to import food, especially rice, in case of a national shortage; but Japan has had to place little dependence on the importation of food. At present not more than ten per cent of the food consumed within the country is imported.[12] The great increase in food supply of the country has come for the most part through internal reorganization.

The West contributed more rapid means of transportation, and the task to which the new government first addressed itself most vigorously was the building of railroads and roads to connect all parts of the country. Japan under the Tokugawas had become a political empire. In the Meiji era the unification was completed, and the country became an economic empire.

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[11] The koku equals 4.96 bushels. The figure for 1835 is based upon an estimate, officially accepted, of the total production of rice for that year as 30,400,000 koku (Asakawa, *op. cit.*, p. 159) and upon an estimate of the population at 30,000,000, based on Droppers' correction (*op. cit.*).

[12] E. C. Grey: The Food Problem in Japan, *Trans-Pacific*, July 30, 1927, investigating food problems in Japan for the League of Nations.

Trade, both internal and external, developed markets for surplus products, and agricultural specialization became possible. Rice continued to be the major crop and to occupy the choice land; but crops that could be produced only with difficulty gave way to others more suited to local conditions. Under the Tokugawas cotton was widely grown, especially in the southern and northeastern parts; now very little is grown. Ever since 1899, the year for which figures are available, there has been a tremendous shift and decline in the districts producing cotton. Osaka, which then led all the other prefectures with a production of 929,000 kwan, now produces less than 7000 kwan (the kwan equals 8.27 pounds avoirdupois). Cotton can be brought in from India or from America, and the land can be used for production of food (see Fig. 4).

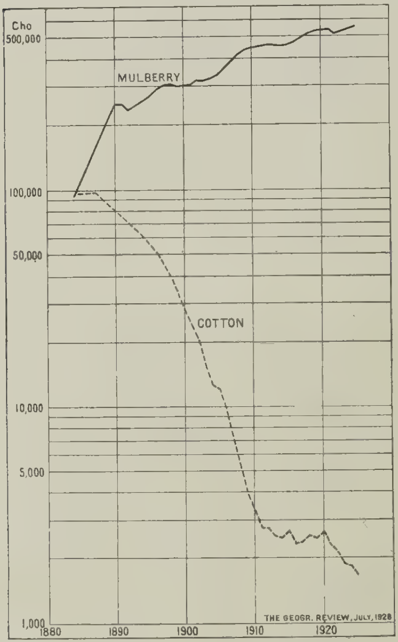

FIG. 4—Specialization has crowded out the cultivation of cotton and increased the area under mulberry in Japan. (Graph on semi-logarithmic scale.)

In Nagano, a prefecture of narrow valleys and steep mountain slopes in the central highland mass, much new land has been brought into cultivation in the last fifty years. During the feudal period all of the flat bottom land and the lower slopes had been put into rice, but the upper slopes were used only for the production of the mulberry required for a silk industry supplying local needs. One of the early railroads penetrated the valleys of Nagano and provided a means for carrying the raw silk to the seacoast where contact with the western world had already created an insistent market. The area in mulberry increased rapidly; and Nagano, a prefecture without much level land, is now highly prosperous. In 1925 the area in mulberry was almost three times as great as the area so used in 1891, and the output of raw silk had increased more than tenfold.

In Shizuoka, another mountainous prefecture, the production of tea has increased threefold since 1890. In all of Japan between 1905 and 1923 the increase in land under dry cultivation (largely mulberry and tea) was 19.2 per cent, and the increase under wet cultivation (rice) was only 8.2 per cent. In Chiba prefecture, east of Tokyo, much land formerly in soy beans is now in rice and beans are imported from Manchuria for the soy breweries.

INCREASE IN PRODUCTION THROUGH BREAKING DOWN OF FEUDALISM

Another influence that cannot be emphasized too strongly in its encouragement of increased production was the breaking down of the feudal system and the removal of its shackles. The sale of farm land was no longer prohibited. The good agricultural fields tended to pass into the possession of the good cultivators, and the poor cultivators gravitated to the poor land. Use of land was no longer restricted, and reclamation of new ground was encouraged.

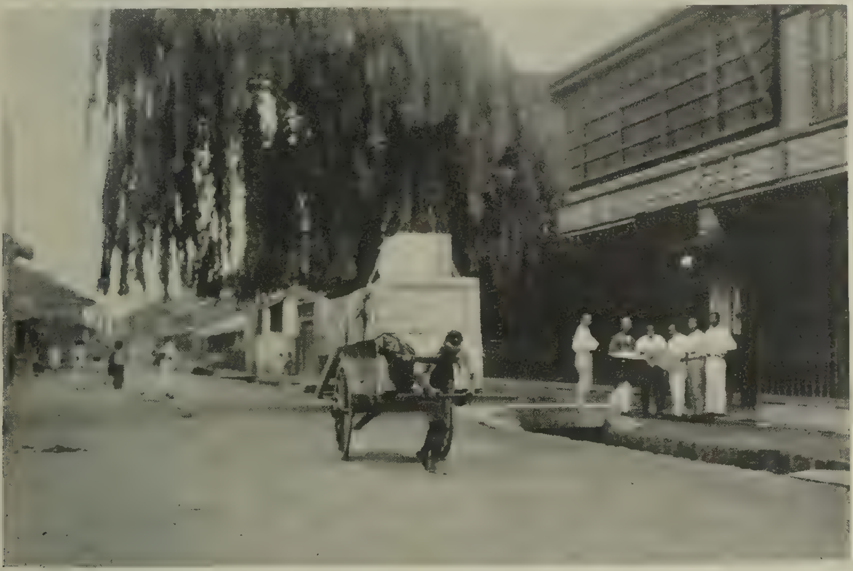

FIG. 5—For local transport man is still the beast of burden. A cartload of tea in a Shizuoka street.

During the Meiji era the production of rice has increased at almost exactly the same rate as the population (see Fig. 9). Statistics for the earlier years are not available, but in 1880 the output of rice for the population of 36 million was 31 million koku, or .87 koku per capita. In 1927 the population had increased to a little over 61 million and the rice yield to about 61.5 million koku, or 1 koku per capita. The increase in output has been due in part to the reclamation of new lands and to the increase of the area of arable land planted in rice, but most of it must be attributed to intensification of cultivation and higher yields. The per capita area in rice has actually shown a decrease from .071 cho in 1880 to .050 cho (a cho equals 2.45 acres) in 1926. For the five years from 1880 to 1884 the average yield per cho was 11.56 koku, and for a similar period ending with 1926 the average was 18.33 koku.

It should be remembered that this great increase in production has been accomplished in a country that for over two centuries was on the very margin of subsistence, with famine following famine. It cannot be explained by the importation of any revolutionary agricultural methods from the west, for rice is still cultivated by hand with the same tools and fertilized in very much the same manner as for centuries. It cannot be explained by any improvement in the environment. Soil, area, topography, and climate all remain as they were. The only significant change has been the securing to the people of a greater degree of economic and social freedom. To the economic unification of the country and to the removal of all the cramping restrictions of feudalism, more than to any other influences, Japan owes the more abundant food supply of the present day. The released population has been able to establish new relationships to its physical surroundings much more productive than the old could ever have been.

The destruction of feudalism deprived the samurai of their incomes, and they were forced into other activities, thus augmenting the productive capacity of the country. Some became farmers, but more were absorbed in the new occupations introduced with the opening of the country, occupations that also provided an outlet for the surplus farm population.

The development of internal and external transportation and communications created a new demand for labor both for construction and for operation. With transport has come trade both foreign and domestic, and the merchants have become something more than engrossers of rice during famine periods. They are no longer a despised group. The great trading families are among the most powerful and influential in Japan.

The creation of markets and the repeal of the old sumptuary laws have encouraged the development of manufacturing industries, but here, as in the case of agriculture, the more significant expansion has come not through the introduction of western inventions and methods, but through the stimulation of the household industries that have been in existence for centuries. Freed of restrictions they have developed rapidly and have offered an outlet for employment to a population increasing beyond the labor demands of the land.

The Search for a Solution

Such are the influences that have produced the Japan of today, a country with a population increasing so rapidly that her leaders are viewing the future with concern. An examination of the area of Japan gives substantial grounds for their fears. Japan is a group of mountainous islands. It is almost impossible to travel anywhere out of sight of a mountain range. At present only 15.6 per cent of the total area is arable, a more limited area than in any other great nation. If only the arable part of Japan is considered, the population density is

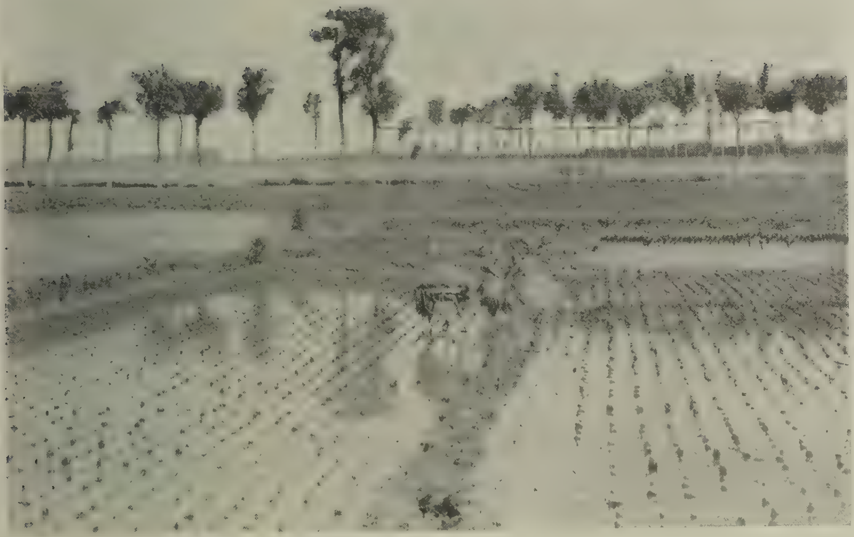

FIG. 6

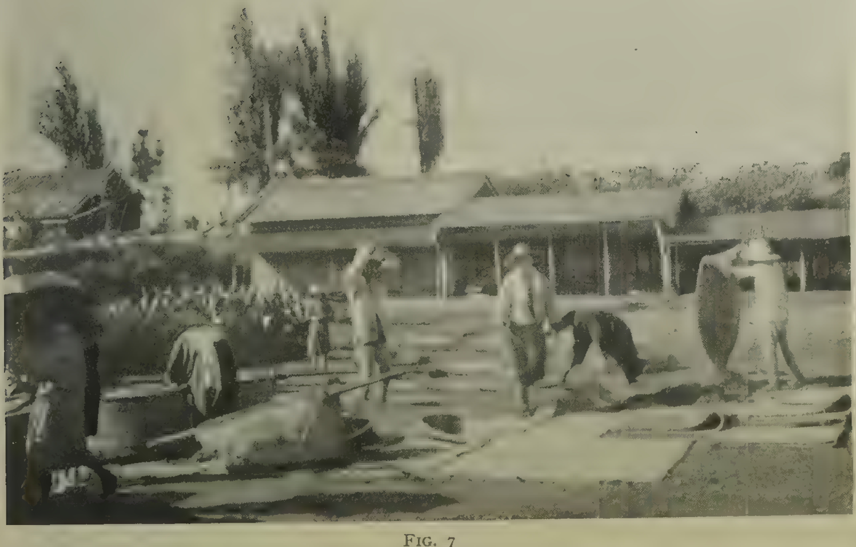

FIG. 7

FIG. 6—Drying rice along the boundary ridges between the fields.

FIG. 7—Threshing wheat in a farmyard near Osaka. The grain is spread carefully on mats so that none will be lost.

some 2500 per square mile. It is this density that the leaders are viewing with alarm, the more so since Japan is still essentially agricultural. Out of the present concern has come the suggestion of a number of possible ways of absorbing the growing population.

Expansion and Intensification of Agriculture

Since Japan is and always has been an agricultural nation it was quite natural that relief should first be sought through improvement in agriculture. The physical structure of the country has greatly restricted the arable area (see Fig. 8). Surrounding the mountainous centers of the islands are narrow coastal lowlands widening out in places to fairly extensive plains or penetrating the highlands along the bottoms of narrow steep-sided valleys. In the small percentage of the surface considered arable are included not only the plains but the lower slopes of many hills and mountains that have been terraced into rice fields by the expenditure of much human toil. Some of the terraces, notably those near Nagano City, are more than a thousand years old, and for all of that time they have been in rice. In the island of Kyushu the outer crater of the volcano of Aso-san has been reclaimed, and now in the crater bottom there are some twenty villages. Rice fields cover the floor and mount in steps far up the crater rim. In the center rises a cloud of sulphurous smoke from the new crater, an ominous warning of the fate that may await those whom the pressure of numbers has forced so near. There is in Japan little more hill land that can be made ready for rice. The plains have long since been claimed by man with the exception of the belts of barren gravel land so common along the lower courses of Japanese streams. A part of those lands may perhaps be reclaimed but only by large-scale operations conducted by the government or by a corporation, and the area thus brought under cultivation will add relatively little to the area already in use.

Though it is a matter of vital importance, no careful survey and classification of the land area of Japan has been made in recent years. It is estimated, however, that there still remain in the country about five million acres that may be reclaimed, an area about one-third of the present arable area. About one-half of it is considered to be suitable for conversion into rice paddies. The total estimate seems large even though it does include the boundary ridges and pathways that are to be saved by the consolidation of small fields and the redivision of farms. If it is accepted, however, with the rather improbable assumption that the land will be as productive as the land now under cultivation, there seems to be the expectation of increasing the food supply by some 33 per cent, or sufficient for a population increase of 20 million.

That this expectation is unduly optimistic seems evident from an examination of the history of land reclamation in Japan. In the twenty years between 1905 and 1925 the arable land was increased by about 1,875,000 acres, or an average annual addition to the land under cultivation of less than 100,000 acres. At such a rate it will require 50 years to reclaim the estimated possible area, but the 20 million population increase will be reached in less than 25 years. It is not likely that even this slow rate of reclamation can be maintained, for the later projects will probably be more difficult. Already a decreasing rate of reclamation is evident. In the ten-year period from 1915 to 1925 the average acreage reclaimed annually was only 50,000 acres, or one-half of the average for the last twenty years. For two of the years there was a decrease in the area of land under cultivation amounting to almost 150,000 acres, indicating that the work of reclamation

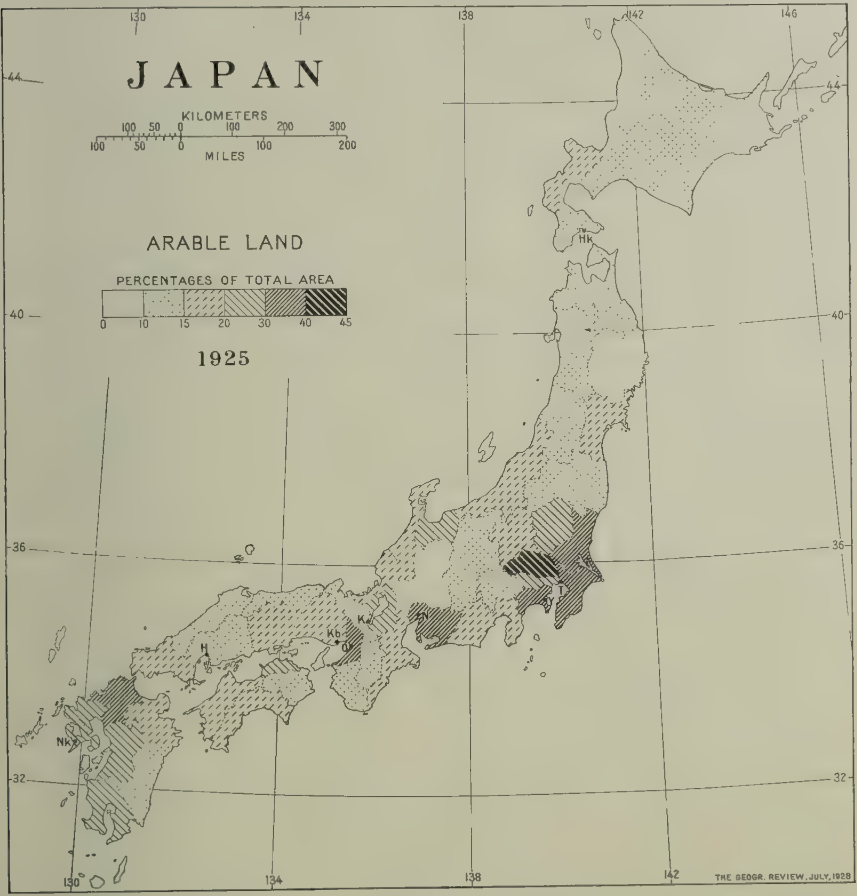

FIG. 8—Percentage of arable land in relation to total area by prefectures, 1925. Scale approximately 1:14,500,000.

has pushed very close to the margin. It is significant that 46 per cent of all the land reclaimed since 1915 has been put into mulberry, not into food crops. Mulberry is grown only on land that is unfit for rice because of soil, topography, or scarcity of water. It is also significant that, since 1915, 49 per cent of the land newly brought into cultivation and 56 per cent of the increase in rice land has been in Hokkaido, the scantily populated north island.

That the government does not have too high hopes of reclamation as a solution of population growth is shown by the announced plan of the recently appointed commission on food and population. The commission has proposed the reclamation of only 75,000 acres per year over a period of 25 to 28 years. It is a feeble effort, for that area will add each year only 30,000 farms of the present average size and will support a farm population of not more than 150,000, an insignificant figure in view of the present annual increase of approximately one million.

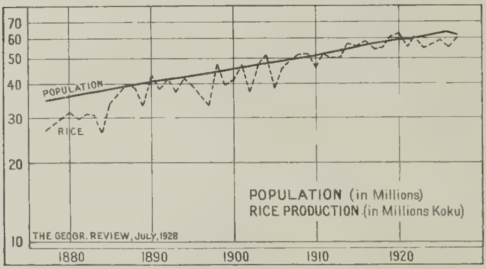

Fig. 9—The population of Japan and the rice production have increased at almost the same rate in the last fifty years. (Graph on semi-logarithmic scale.)

Some increase in agricultural output is to be expected from improvements in farming methods. Since 1880 there has been an increase of 93.6 per cent in the total production of rice, three-fourths of which has been due to a higher yield per acre and only one-quarter to an increase in area under cultivation. This is a remarkable record, but it does not contain much promise for the future, for it is an indication not only that land is scarce but that the Japanese are already getting the most out of what they have. There would be more hope for further increase if the Japanese had not proved themselves to be such skillful farmers. They have much to teach the western world in the maintenance of soil fertility and in forcing the land to bring forth large yields. The output of rice for the five years 1921–1925 averaged 2350 pounds per acre. In the United States it was only 1076 pounds; and in Java, another land of intensive cultivation, it was 927 pounds. From planting to harvesting, Japanese agriculture is carried on almost exclusively by hand without the aid of machinery or even of animals. It is difficult to see how it can be made much more intensive, for after all there is a limit to what the land can be made to produce. Already the yield per acre is advancing at a much slower rate than in the earlier years of the modern period (see Fig. 10). Certainly it is not keeping pace with the increase in population. Japan cannot count on intensification as a solution of the problem.

Possibilities of a Change in Diet

There is perhaps a possibility of providing for a somewhat larger population by a change in diet. It is even probable that such a change would not only increase the available food supply but would prove beneficial to the health of the people. Dr. Egerton Charles Grey has recently completed a study of the food problem in Japan for the League of Nations. His preliminary report contains some interesting conclusions.[13] He has found that as far as quantity is concerned there is no shortage of food in Japan and that there has not been at any time since the beginning of the Meiji era. It is his opinion, however, that the Japanese are poorly nourished because of the preponderance of rice in their diet. Certainly any foreigner who spends a few weeks in Japanese inns, delightful as they are, finds the diet very trying. A greater dependence on vegetables and fruit would undoubtedly cut down the demand for rice. The land might be made to yield more starch in the form of the white potato or sweet potato. In recent years Germany, with much less intensive methods than are practiced in Japan, has been able to secure slightly more starch per acre from potatoes than Japan has secured from rice. The sweet potato is more at home in the climate of Japan than the white potato, and it will grow on land too steep and too dry for rice. Changes in diet, however, are not easy to bring about even among the most progressive peoples. It is certain that the Japanese would regard a change from rice as a lowering of their standard of living. It could come only after a long educational campaign or as the result of a food shortage. It is one of the least promising of the proposed solutions for the Japanese population problem.

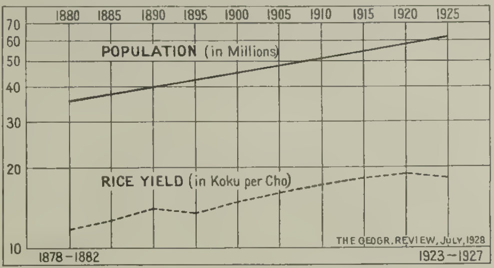

FIG. 10—Comparison of rice yield per cho and population growth. Recently the increase in yield has not kept pace with the increase in population. The yield is by five-year averages; the population is charted for every fifth year. (Graph on semi-logarithmic scale.)

Population Relief through Emigration

Other nations have sought relief for a too numerous population in migrations into less densely populated lands. When Japan finally began to look about for new lands to absorb her surplus population, it was a century too late. She was in much the same position as Germany after the formation of the Empire in 1871. Very few parts of the world remained that were not already claimed by one of the great colonizing

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[13] *Trans-Pacific*, July 30, August 6, and August 13, 1927.

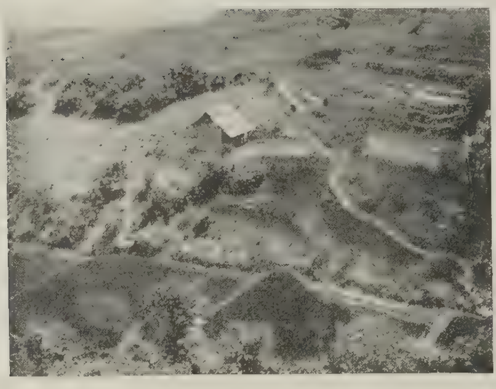

FIG. 11

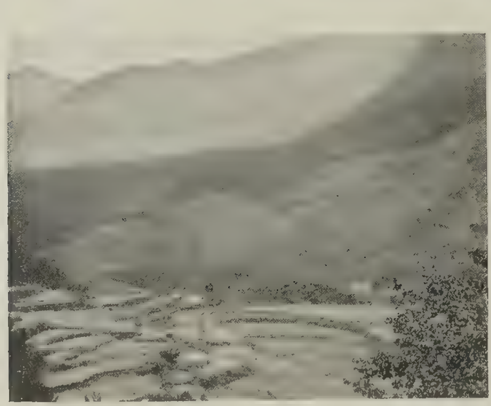

FIG. 12

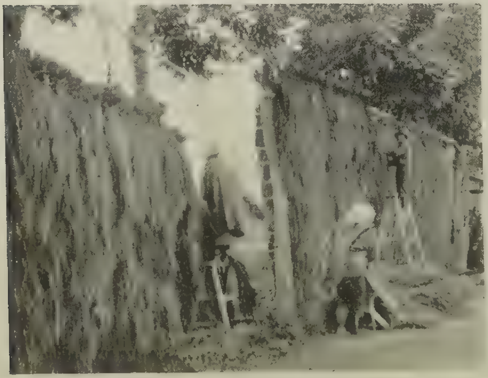

FIG. 13

FIG. 11—Steep slopes are carefully terraced for tiny fields of rice.

FIG. 12—The crater floor of Aso-san is in rice; tea is grown on some of lower slopes; forests above.

FIG. 13—Rice drying on rope frames stretched between roadside trees.

powers of Europe, and the lands that had not been appropriated were of little value for settlement. Japan, however, lost little time in striving to overcome the handicap of a late start. In 1875 she secured from Russia the Kurile Islands in exchange for her claim to the island of Sakhalin. In 1876 she seized the Ryukyu Islands. She was victorious in her first great war, the war with China in 1895, and Formosa and the Pescadores were added to her territory. By the war with Russia in 1904–1905, Japan gained a foothold on the mainland of Asia and regained the spoils the European powers had forced her to surrender at the conclusion of the war with China. She secured a dominant position in South Manchuria and a protectorate over Korea which gave way to annexation in 1910. She also recovered the southern half of Sakhalin traded to Russia in 1875. By the Treaty of Versailles Japan was given a mandate over some of the German islands in the South Pacific and acquired the German claims in Shantung, claims which have largely been returned to China.

With all her strenuous efforts to acquire territory extending over more than half a century, Japan has not been able to build up a large empire. Her external possessions constitute only about 44 per cent of her total area, and some of her claims are not any too secure—her hold on Manchuria for instance. Korea is restless, and Japan has been forced to accede to a number of the Korean demands.

Nor has the territory acquired proved to be an effective outlet for an overflowing population. The Japanese have not migrated in any large numbers to the empty parts of the main group of islands, to her outer possessions, or to the controlled zone in Manchuria.

HOKKAIDO

For a time Hokkaido was looked upon as the solution of the Japanese population problem. It has been called the Northland of Japan. Certainly it is the Japanese frontier area. At the beginning of the Meiji era, it was an empty wilderness inhabited only by a few tribes of the Ainu. In 1869 a Colonial Development Office was created as a part of the new government of Hokkaido. American engineers, geologists, and agriculturists were brought in to build

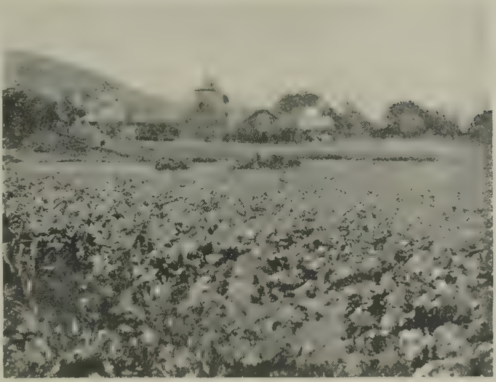

FIG. 14

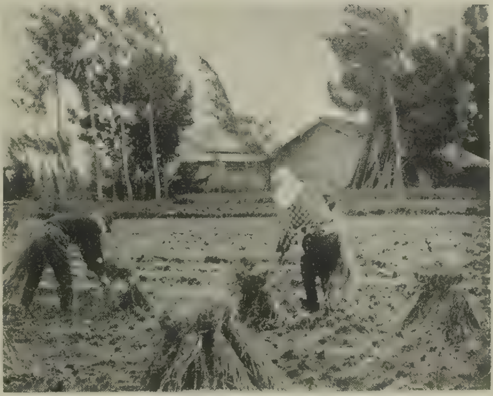

FIG. 15

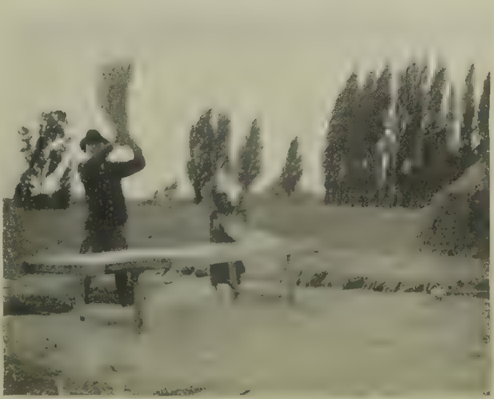

FIG. 16

FIG. 14—Barn and silo, dairy cows, and turnip field of this Hokkaido farm recall New England.

FIG. 15—Harvesting rice in Hokkaido in October. The heavy clothing is evidence of the rigorous climate.

FIG. 16—Threshing oats. Even in Hokkaido with its larger farms little machinery is used.

railways, open the coal fields, and assist in the development of the island. An agricultural college on an American model was established in Sapporo, the capital; and American fruits, vegetables, and grains were introduced. An active campaign to colonize the island was launched by the government. In 1869 the population was 58,000, or less than 2 persons per square mile. By 1901 it had increased to over one million, and by 1925 it exceeded two and a half million.[14]

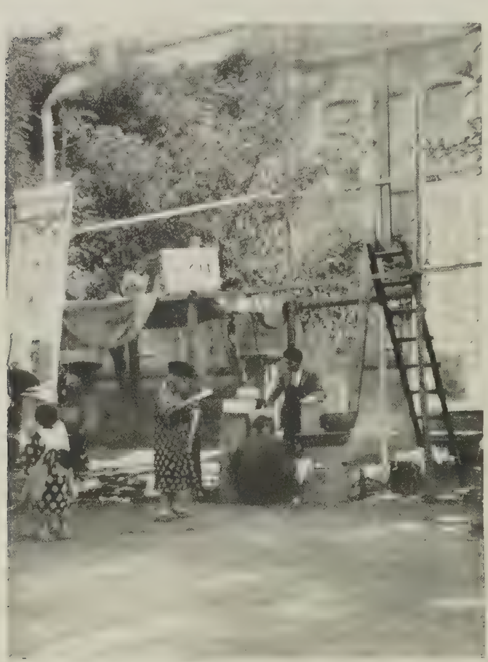

FIG. 17—The stove has invaded Hokkaido with its New England climate: its use demonstrated in the street market.

Despite this seemingly rapid rate of increase, however, Hokkaido has not been an important outlet for the population of the main islands. In only two years, 1907 and 1917, has the total net increase, including births as well as migrants, exceeded 100,000; and in both 1923 and 1924 the rate of increase per 1000 was less than for all of Japan. In 1926 the Hokkaido government announced that the island could accommodate 1,770,000 more people,[15] or about the increase of Japan for two years. It was also announced that the government planned to send 90,000 farmers a year from Japan to Hokkaido for the next twenty years. There is little probability of the successful execution of such plans unless there has been discovered some new and extremely potent method of encouragement. The Japanese official figures on the population of Hokkaido are confused, but apparently the greatest annual movement into the island was about 38,000 during 1917, 1918, and 1919. In 1924 less than 10,000 migrated into Hokkaido from other parts of Japan, and more than 11,000 returned to the southern islands or to other parts of the Empire. The story is much the same for all of the years since 1920.

Hokkaido will play no important part in absorbing the growing population of Japan. The area of arable land is not large, and the climate is rigorous with winters much like the winters of New England.

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[14] Hokkaido Statistical Bureau, Statistical Report, Part I, 1924 (in Japanese). Also *Résumé Statistique*, 1926.

[15] *Tokyo Nichi Nichi*, June 26, 1926.

The immigrant must make revolutionary changes in his way of living, and the Japanese have never proved themselves to be a people capable of easy adaptation to unaccustomed and unfriendly conditions. The lightly constructed houses of southern Japan are not sufficient, and Hokkaido architecture is more Occidental than Oriental.

KARAFUTO

Karafuto, the name given to the Japanese part of the island of Sakhalin, is even less likely to attract Japanese emigrants, for it is several degrees farther north than Hokkaido and its winters are much more severe owing to its position near the Asiatic continent. There is some cultivation of wheat, but the economic life is based almost entirely upon the fisheries, forests, and mines. The total Japanese population is 138,000; and in 1923, according to the *Japan Year Book*, 9340 peasant settlers entered Karafuto from Japan, 5700 of them from Hokkaido. The Director of Agricultural Affairs of the Sakhalin Government recently informed the Commission for the Investigation of the Problems of Population and the Food Supply of the Imperial Government that the island had need of 100,000 workers for the exploitation of coal mines and for the lumber industry, not a very attractive prospect for the warmth-loving Japanese farmer.

KOREA

The climate of Korea, the southern part at least, is somewhat more to the liking of the Japanese, but Korea is already rather densely populated, having 229 per square mile in 1925, and the topography is rugged. The standard of living of the Koreans is lower than the standard of the Japanese. The wage scale is about one-half of the Japanese rate. Korean boys are brought into Japan to serve as helpers in industries where wages must be very low.

The Governor-General of Korea has announced to the food and population commission that an area of 500,000 acres of rice land has recently been developed and that 350,000 Japanese are required to work it, but the Japanese farmer finds it difficult to compete with the Korean farmer. If so much land is available, it is difficult to understand the Korean immigration into Manchuria and the report that Viscount Goto on his recent trip to Russia discussed with the Soviet Government the possibility of emigration from Korea to the rice fields of the Siberian Maritime Provinces. It would seem that Korea also is seeking relief for population pressure.

There has been a considerable movement from Japan into Korea, but almost half of the 400,000 Japanese in the country in 1924 lived in the eight largest cities. They were not farmers; they were merchants, bankers, and officials. Korea may possibly become a source of food and raw materials for Japan, but it will not provide land for the surplus Japanese farmers.

FORMOSA

Taiwan, or Formosa, has a moist, hot climate capable of a large production of tea, rice, sugar, camphor, and timber. The Japanese have achieved a considerable degree of success in their subjugation of the natives and the administration of the island, but the total population of 4,000,000 in 1924 included only 183,000 Japanese. The Director of Colonial Affairs recently stated that Formosa could absorb 300,000 Japanese within the next 10 years. Since 1915 the increase in the Japanese population of Formosa has averaged less than 5000 per year.

The outlying parts of the empire offer little relief for Japan's population problem. The pioneer areas are all lands of limited possibilities that can only be brought into use slowly. Even accepting the claims that the heads of the various colonial governments are now making to the Imperial Government, it would seem that the colonies, including Hokkaido, can absorb in the next twenty-five years a total of less than 2,500,000 migrants. In view of the evidence at hand it is likely that these claims are pious hopes from enthusiastic administrators rather than considered estimates of potentialities.

MANCHURIA

At the conclusion of the war with Russia, Japan acquired the Russian lease on the Kwantung Province, an area of 1300 square miles in the southern part of the Liaotung Peninsula, Manchuria, and also the South Manchuria Railway with control of a narrow strip along the right of way.

Manchuria was looked upon as the land of promise, and the Japanese government early announced its intention of sending one million colonists within a period of ten years into the territory under Japanese control. By the end of 1923, almost 20 years after Japan had taken over the territory, there were only about 87,000 Japanese in Kwantung out of a total population of 707,000, and practically all were in the two cities of Dairen and Port Arthur. In the railway zone there were 82,000 out of a total population of 238,000. There were not more than 35,000 Japanese in the other parts of Manchuria not under Japanese control, making a total Japanese population for all of Manchuria of only a little over 200,000. It is also significant that only about one-half of the Japanese in Manchuria are agriculturists. The remainder are merchants or are attached to the South Manchuria Railway or to the enterprises established by it. In 1924 in Kwantung

Leased Territory there were 167,087 Chinese farmers but only 148 Japanese farmers according to the Director of the South Manchuria Railway.[16]

Manchuria is a rich land. The area is extensive, the soil fertile, and the proportion of plains much larger than in Japan or even than in China proper. In 1923 the population density was only 61 per square mile. Since the establishment of the Chinese Republic in 1910 there has been an annual movement of laborers for the harvests, but most of the workers returned home at the end of the season. More recently a flow of permanent settlers with their families has set in, partly because of the disturbing and destructive effects of the many civil wars in China and partly because of famines. The present famine in Shantung Province is responsible for a greatly accelerated movement. It has been stated on good authority that over a million[17] Chinese are entering Manchuria each year and that more than half of them are remaining as permanent settlers.

The Chinese peasant works for a year or two as a laborer. Then he takes a piece of land and for a time leads a very meager existence. He perhaps digs a cave to serve as a shelter for himself and family until there are time and money to provide a better home. His food supply will be scanty and precarious, but he has always been very close to the margin of subsistence. With such a standard of living the Japanese farmer finds it impossible to compete. The climate of Manchuria is more rigorous than that of Japan, but it is warm enough to permit the cultivation of rice and in itself probably would not prevent Japanese migrations. The Japanese have never been able to establish the practical right to lease land in Manchuria for settlement or for any other purpose. Though one of the twenty-one demands of 1915 gave to Japan that right, the Chinese have managed to put effective obstacles in the way of its enjoyment. Even for extensions of the South Manchuria Railway it has been necessary to secure leases of land through a Chinese who thus becomes assured of a good income for life. The Chinese farmer who takes land in Manchuria benefits from any increase in value. The Japanese settler cannot enjoy such increment. This impossibility of competition with the Chinese peasants seems to be the fundamental cause of the failure of Japanese settlement in Manchuria, though it is true that the Japanese made no more headway during the period before the present Chinese movement began.

Manchuria is one of the few unexploited regions of the middle latitudes, and its position adjacent to areas of dense population makes it one of the world's danger spots. The stage seems to be set for a colossal conflict with the outcome very much in doubt. The contest for Manchuria, for years a two-sided struggle between Russia and Japan, has now become a three-cornered struggle with the active entrance of China. Russia and Japan have the organization and the military strength; China is badly torn by civil wars, but she has the advantage of proximity and in her migrants a most effective weapon to protect the sovereignty that still remains to her and perhaps even to regain the rights that she has been forced to surrender.

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[16] Kimmochi Okura: Japan's Future in Manchuria, *Japan Advertiser*, August 12, 1926, p. 5.

[17] *Trans-Pacific*, September 24, 1927. Also Chinese Government Bureau of Economic Information, Peking; C. W. Young: Chinese Labor Migration to Manchuria, *Chinese Econ. Journ.*, Vol. 1, July, 1927, noted in *Geogr. Rev.*, Vol. 17, 1927, pp. 674–676.

If a conjecture may be permitted, China will not be the loser in this struggle. Though the Japanese are inclined to underrate the capacities of the Chinese, it is the Chinese who are making the greater progress in Manchuria. That opinion is beginning to gain ground in Japan. As a Japanese economist recently stated: "If there were ever a hope for Japanese dominance [in Manchuria], it was the first ten years during which we wished to colonize to the extent of 1,000,000 immigrants. It is too late now."[18]

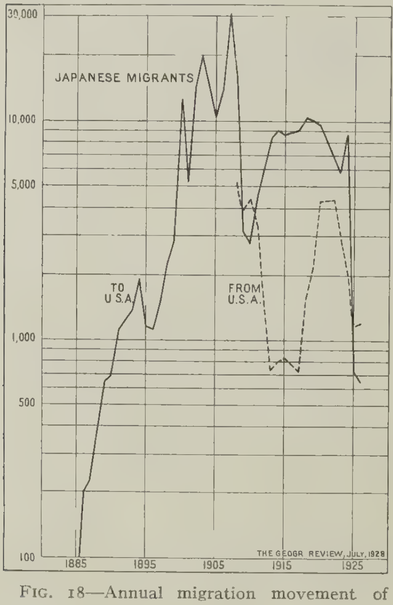

FIG. 18—Annual migration movement of Japanese to and from the United States, 1885–1926. (From the United States Department of Labor, Annual Report of Commissioner General of Immigration, 1926.)

EMIGRATION TO FOREIGN COUNTRIES

Japan has in the past attempted emigration into foreign countries, but the movement has been of far greater significance for the political issues it has raised than for the actual numbers involved. Foreign migrations did not become important until the last decade of the nineteenth century. During the previous ten years the largest annual migration to the United States was 640 in 1889, and in 1880 it was only 4. Even during the height of the emigration to the United States, just prior to the formulation of the Gentlemen's Agreement of 1907, the average number of Japanese to come to this country annually was less than 18,000, and they were returning home at the rate of about 4000 per year.[19]

Emigration in recent years has been particularly unimportant. Prime Minister Tanaka in July, 1927, stated that not more than 15,000

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[18] S. Washio: *Trans-Pacific*, Oct. 29, 1927.

[19] U. S. Department of Labor, Annual Report of the Commissioner General of Immigration, 1926, pp. 166, 170.

Japanese were migrating to foreign countries annually. For the years from 1920 to 1924 this number was exceeded by the repatriations.[20]

According to the Bureau of Statistics of the Imperial Cabinet there were 625,000 Japanese residing abroad on October 1, 1925. The *Osaka Mainichi* (June 30, 1926), however, has stated that that number included about 22,000 Koreans and Taiwanese and about 57,000 students, officials, tourists, army and navy officers, and others who should not be considered as migrants. The total number of emigrants was therefore approximately 546,000; and of that number probably 45,000 were farmers, merchants, industrialists, and workers in Kwantung Province, in reality Japanese territory. Of the remaining 500,000, 50 per cent were in the Continental United States, Hawaii, and the Philippine Islands, lands now closed to Japanese.

TABLE I—ESTIMATED NUMBER OF JAPANESE EMIGRANTS TO BRAZIL*

1908	799	1914	4,526	1920	983
1909	4	1915	39	1921	923
1910	911	1916	35	1922	965
1911	0	1917	3,883	1923	891
1912	2,859	1918	5,903	1924–1925	3,689
1913	6,957	1919	2,678	1925–1926	4,908
				1926–1927	8,599

* *Japan Advertiser*, August 19, 1926; *New York Times*, November 13, 1927.

The lands bordering upon the Pacific Ocean that are seemingly the most suitable for Japanese settlement are for the most part under the control of English-speaking people, and they now have rigid restrictions, if not exclusion acts, with respect to the immigration of all Orientals. On the other hand, the Japanese are a home-loving people. They have never shown themselves to be pioneering folk eager to make new settlements or to combat strange surroundings.

Practically all of the few suitable localities remaining open to Japanese are in South America. Japanese emigration is being directed toward Brazil and to a less extent toward Peru and the Argentine. The movement to Latin America was of no importance as long as the United States permitted Japanese to enter freely, and even since the Gentlemen's Agreement it has been sporadic. There are now in Brazil approximately 55,000 Japanese. In the official year 1926–1927, of the 16,184 emigrants leaving Japan 8599 went to Brazil.[21] Most of the Japanese are settling in São Paulo, but some are moving to southern Brazil. The Brazilian and Japanese governments are coöperating in efforts to stimulate this emigration further.

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[20] Japan, *Financial and Economic Monthly*, August, 1927. Migration Movements 1902–1924, *Internatl. Labor Office Studies and Repts.*, Ser. O (Migration), No. 2, Geneva, 1926.

[21] *New York Times*, November 13, 1927.

The attention and encouragement given to emigration by the present Japanese Government are strong evidence of the desperate circumstances of the country. Most elaborate plans have been formulated. Emigrant associations are being organized under the Japanese Foreign Office and provisions are being made for the physical comfort of the emigrants in their new homes. The Foreign Office is providing a subsidy of 200 yen for each individual, and the Home Office is lending funds for passage money and for the purchase of land; but the funds available are limited, and the present plans provide for only 200 families in three years. Financial assistance is being granted only to those who intend to leave Japan permanently and to become citizens of the countries in which they establish themselves. To stimulate interest in foreign lands a colonial museum is to be established in Tokyo, and colonial or emigrant schools have already been started to train prospective emigrants in the language, customs, resources, and economic possibilities of their future countries.

But despite all of the publicity given to them, these plans should be heavily discounted. They have a strong political flavor and have been put forward by the party in power to win popular support. Practically every one of the plans has served the same purpose at one time or another in the last quarter of a century; but they have all remained paper plans, and the results accomplished are of no importance. Japan really places little hope in emigration to solve her population problem.

Birth Control

The possibility of positive checks on population growth has received serious consideration only within the past few months. Three years ago the discussion of birth control was "dangerous thought" and was hunted out and suppressed by the police as vigorously as communism is today. In the fall of 1926 at a luncheon given by a group of professors of Japan's most liberal university, birth control was mentioned in the course of a discussion of Japan's future and of her population problem. It was dismissed as a method of population control because it was so entirely contrary to Japanese ideals. It is significant of the changing trend of Japanese thinking that the professor who voiced the most decided objections to birth control has since declared in a printed statement that it is the only possible solution of Japan's population problem.

It is a change in philosophy that is today very widespread in Japan. The birth control movement has made little headway with the masses, but it is being discussed widely in newspapers and magazines. It is openly advocated by many economists. Recently it was debated before a large audience in Tokyo by a professor of the Tokyo Imperial University and a professor of Waseda University. It is even being considered by the government, and in view of the circumstances that encompass the country it seems probable that within a few years there will be a complete reversal of government policy to an active encouragement of positive checks on the population growth. The strong paternalistic government of Japan is well suited to make the experiment with birth control not only for the limitation of numbers but for the improvement of the stock.

A Brief Consideration of Industrialization

One other means of providing for an increasing population remains to be considered. Other countries, notably England and Germany, have been able to provide for greater numbers by an intensification of the use of their land area through the developing of manufacturing industries. In Japan during the past half century, the development of manufacturing industry has been actively encouraged by the government, in the earlier years in an effort to make the nation strong economically and politically and in more recent years as a means of providing employment and food for the increasing population. Industrialization is today, more than ever before, a leading issue in domestic politics. Numerous official commissions have been appointed recently to investigate the condition of industry, to survey the resources of the country, and to devise methods of encouraging the developing of manufacturing.

Despite the efforts of half a century, however, Japan is not an industrial nation. In 1924 there were in Japanese factories fewer than two million workers, representing probably less than ten per cent of the population gainfully employed. During the war Japan participated in the world-wide expansion of manufacturing and experienced the greatest industrial advance of her history. In the five-year period from 1914 to 1919 there was an increase of 838,000 in the number of factory workers, or an average increase of 167,600 annually.

The expansion proved to be solely a war product, for Japan experienced in a severe form the post-war depression. In the five year period from 1919 to 1924 the number of factory workers declined by about 48,000.[22] It is undoubtedly a temporary setback, and Japanese manufacturing will advance again; but even if the spectacular expansion of the war period could be maintained permanently, a very unlikely development, the increasing demand for factory workers would not be sufficient to absorb the surplus population.

The subject of industrialization is a large one and demands a more detailed consideration. A later discussion will present an account of the progress of manufacturing in Japan, of specific industries, of their economic and geographic background, and an analysis of their probable future development.

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[22] Japan, Dept. of Commerce and Industry, Statistical Rept. of Factories, 1924, p. 1 (in Japanese).

THE POPULATING OF WISCONSIN

Guy-Harold Smith
The Ohio State University

[With separate map, Pl. III, facing p. 420]

FOR a hundred years agricultural pioneers have been laboring to convert the wilderness of Wisconsin into the countryside of prosperous settlement. Figure 1 shows an individual farm on the agricultural frontier of today in course of reclamation from land abandoned by the lumbermen. The century of pioneering has not been sufficient to erase completely the wilderness; and as will be shown later a part of that frontier still remains in the northern part of the state.

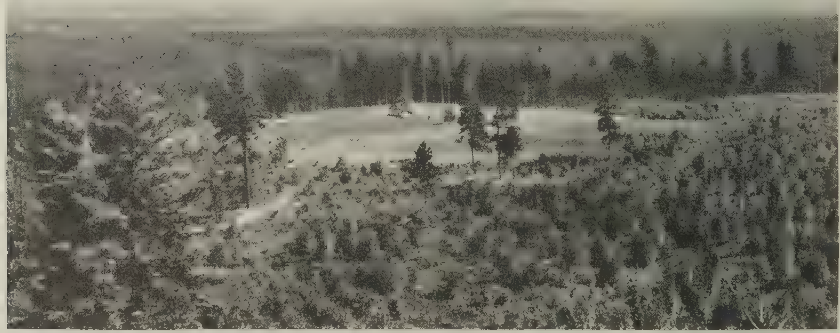

FIG. 1—A farm in the making in northern Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

The first farmers who ventured into southern Wisconsin toiled to win wheat land from the virgin prairies and woodlands. Gradually the culture of wheat moved on westward to the treeless prairies beyond the forest belt. But in Wisconsin, the agricultural frontier moved progressively northward; and the individual farmers, with characteristic ambition and fortitude, labored to win their farms from the forest. Times had changed, and a diversity of agriculture replaced the specialization in wheat; it is well that the change had come, for to the north the open prairies were not to be found. Still farther north the modern pioneer has a slightly modified objective. Dairying has become a specialized counterpart of his diversified agriculture. Some of the cut-over land can be used for pasture, and the farm animals assist the pioneer in converting the new land into a prosperous farm.

The dot maps of Plate III present in a graphical manner the northward movement of the frontier and at the same time indicate the intensification to the rear commonly called the urbanization movement. Growth of cities and villages has kept pace with steadily moving frontier, and in recent years the attractiveness of urban life has drawn some of the rural inhabitants to the cities. Simultaneously, there have been these two tendencies: one toward a dissemination of the rural inhabitants, and the other a centralization of the urban peoples. "It is for *demography* to undertake the study both of that concentration and of that dispersion."[1]

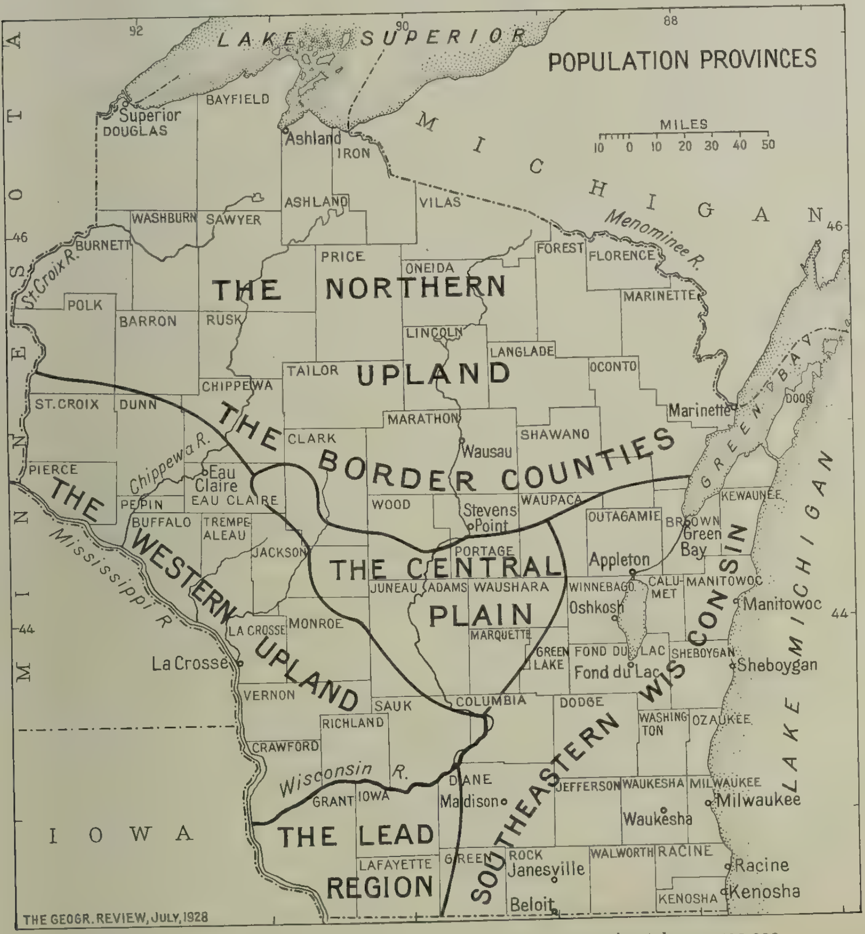

FIG. 2—The population provinces of Wisconsin. Scale approximately 1:4,400,000.

The regions selected for this study are largely physiographic, but the order of their presentation is more or less historical in order to show how Wisconsin came by its present population distribution.

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[1] Lucien Febvre: A Geographical Introduction to History, London and New York, 1925, p. 34.

The Lead Region

Unified by the presence of a mineral resource and distinguished from the contiguous territory, the lead region of the upper Mississippi Valley has had a special history. Wisconsin includes within its borders the northern portion of that mineral region and has shared in its history.

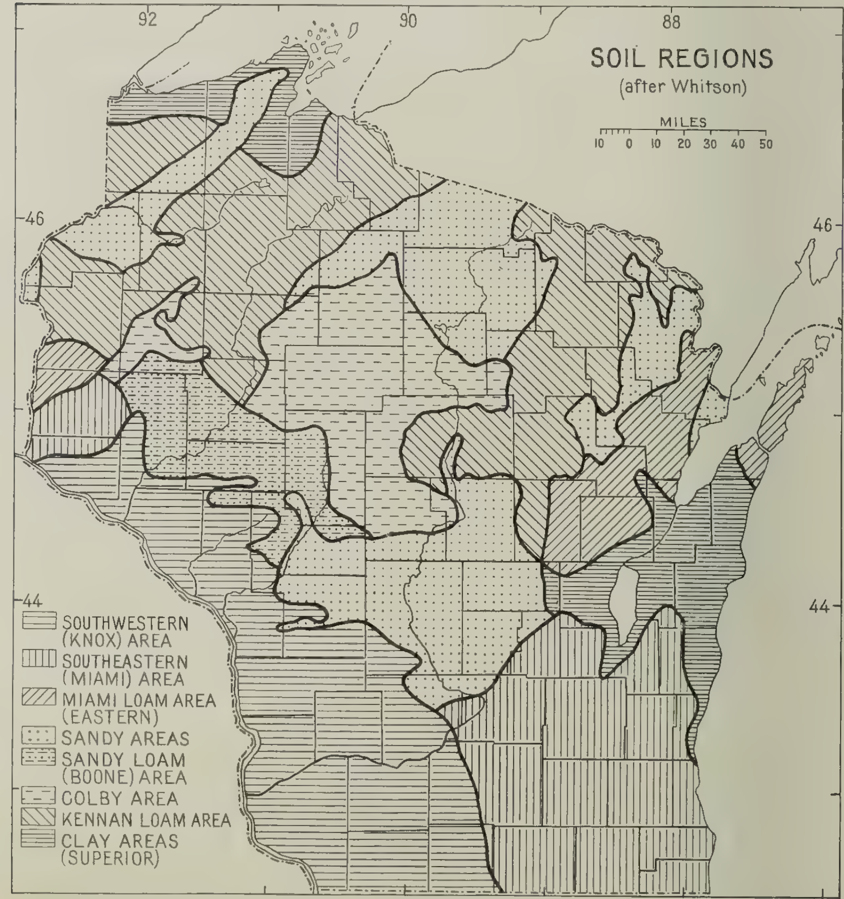

FIG. 3—The soil regions of Wisconsin. (After A. R. Whitson: Soils of Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 68*, 1927.) Scale approximately 1: 4,400,000.

The year 1820 is usually chosen as marking the close of the great migration. "With the admission of Missouri [1821] the great migration came to an end so far as new States were concerned, and the heavy shift of population subsided for another ten years."[2] Just as this historic movement began to abate the settlement of southwestern Wisconsin was begun; thus the first movement into the area was slow.

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[2] Frederic L. Paxson: History of the American Frontier, 1763–1893, Boston and New York, 1924, p. 219.

A few miners had reached Wisconsin by 1820, but it was not until 1825 that the frenzied movement began. As the frontier of settlement approached the lead region the pioneers, attracted by the prospect of wealth, threw out a salient in advance of the agricultural frontier. The lead had been known since 1690 when the French traders bargained with the Indians for lead as well as for furs.[3] It was the approach of the frontier that increased the importance of this mineral resource, making it for a time the dominant attraction in the region.

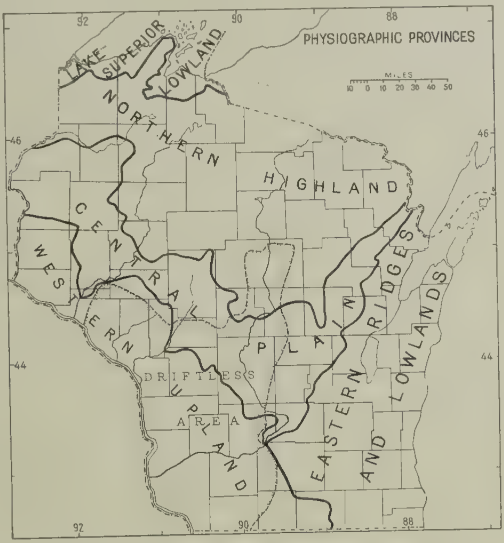

FIG. 4—The physiographic provinces of Wisconsin. (After Martin, *op. cit.*, footnote 10.)

One significant fact concerning the early settlement of the southwestern part of the state was the direction of the movement. "The laws which, as a rule, generally confine the migration of the human race to isothermal zones and similarity of climate, were to be set at defiance, and the emigrant from the mild climate of Tennessee, Kentucky, Missouri, and southern Illinois was to exchange the balmy and genial atmosphere to which he had been accustomed, for one in which during nearly half the year all nature is bound with icy chains and covered with a robe of snow."[4] In this we find the explanation of the fact that so many people of southern origin found their way into southwestern Wisconsin: they had been attracted by the lead and guided by the Mississippi River and its tributary, the Galena, into the mineral lands.

It is difficult to ascertain the number of people in the lead region because of the scattered nature of their activity and the continual increase from immigration. For the years 1825 and 1826, the Superintendent of the Lead Mines reported that: "On the 1st day of July, 1825, there were at those mines about one hundred men; on the 31st of December, 1825, one hundred and fifty-one men; on the 31st of March, 1826, one hundred and ninety-four; on the 30th of June, 1826, four hundred and six; and on the 31st of August, 1826 (the date of the last report), there were four hundred and fifty-three men. You will observe the increase has been gradual, and the numbers are still augmenting."[5] This was just the beginning of settlement, for in 1828 the northward drift into Wisconsin was heavier than in any previous year.[6]

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[3] Louise Phelps Kellogg: The French Régime in Wisconsin and the Northwest, Madison, 1925, p. 359.

[4] Moses M. Strong: History of the Territory of Wisconsin from 1836 to 1848, Madison, 1885, p. 118.

About 1830 there began a stream of miners from Cornwall that has left in this region thousands who now claim one or more ancestors of Cornish origin. This influx is closely related to the trend of the lead-mining industry. About 1850, Cornish miners were drawn away from the lead mines to the gold fields of California. "It is estimated that in 1850 there were about 6000 native Cornish in Wisconsin, making up about one-sixth of the total population of Grant, Iowa, and Lafayette counties."[7]

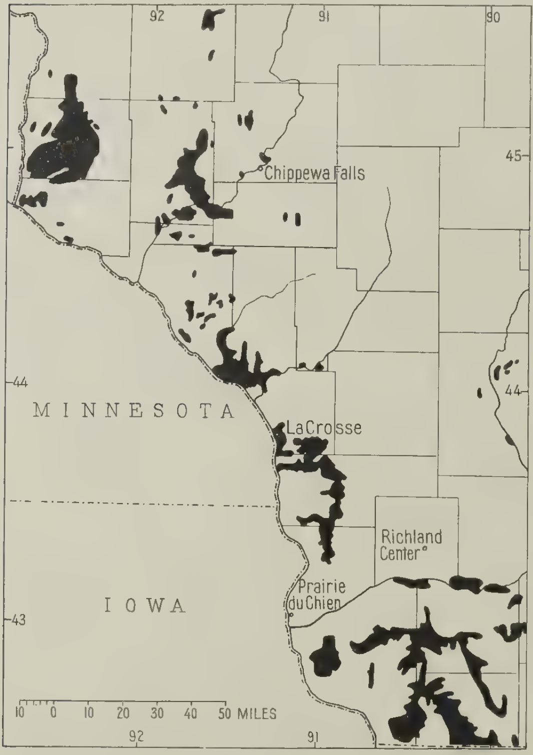

FIG. 5 —The prairies—in black—of western Wisconsin. (After Martin, *op. cit.*, footnote 10.)

The lead mining brought with it a certain amount of agriculture. There was a local market for farm produce; and after the Black Hawk War (1831–1832), which made the region safe for settlers, there began a steady stream of farmers into the area. In fact many found the fertile prairie soils more valuable than the uncertain business of mining. The lead ore was found widely disseminated in the zone above the water table, and this invited individual operations and produced a population dispersion rather than the usual concentration around a mine shaft. In effect they were miner-farmers and depended upon season or price of lead to determine to which industry they should devote their attention. Many came to the lead region of the upper Mississippi Valley to mine lead but remained to farm when the agricultural frontier had overtaken them. The fertile upland prairies were easily made productive by merely turning the sod and planting wheat and corn, the two most important cereal crops of the frontier. From one of the earliest reports concerning the landscape of this region it is determined that about 37 per cent of the area was originally prairie and 63 per cent woodland.[8] The ease with which the land could be farmed brought the prairies into competition with the lead as a dominant element of the environment (Fig. 5).

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[5] *19th Congr., 2d Sess., House of Repr. Exec. Doc. No. 7*, 1826, p. 8.

[6] William O. Blanchard: The Geography of Southwestern Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 65*, Madison, 1924, p. 57.

[7] *Ibid.*, p. 31.

The first reliable quantitative data on the population of Wisconsin, other than the estimates and partial enumerations at Green Bay and Prairie du Chien, are those of the United States Census for 1830. Iowa County, which included all of the lead-producing region in Wisconsin, had 1589, Brown 964, and Crawford 692, making a total of 3245 for the region.

The agricultural pioneers, reaching this region about 1832, created a demand for a land survey, which was begun in 1833 by the erection of the Fourth Principal Meridian through the heart of the lead region. From this line, and with the northern boundary of Illinois as a base, the surveying progressed westward toward the Mississippi River and eastward toward Lake Michigan where the pioneers were penetrating into eastern Wisconsin.

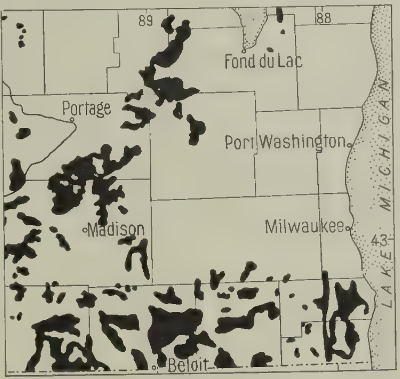

FIG. 6—The prairies—in black—of southeastern Wisconsin. (After Martin.)

The three counties of Grant, Iowa, and Lafayette usually referred to as the lead region reached their maximum population about 1870. Since that time there has been an increase in only the larger cities and villages. The rural districts have steadily declined in population. The total number in 1870 was over 85,000—the maximum recorded in any census enumeration. In 1920 the total was 80,550. From 1890 to 1920 the number living in incorporated cities and villages increased from 18,534 to 30,705; and in the rural districts there was a reciprocal decrease from 60,499 to 49,845 in the thirty-year interval, or a removal from the farms of 350 annually. The lead region is characteristic of the older, essentially rural communities.

Agriculture gradually replaced mining as the dominant economic adjustment, although lead is still mined. After the Civil War zinc became of some importance; under the modern methods of mining both lead and zinc are recovered, and the mining population is definitely localized in certain communities.[9] The region has taken on the aspect of the truly rural communities in the driftless portion of the Western Upland. Mining is important locally and enters into the regional economy; but most of this section is agricultural and is destined to remain rural, with a few villages and small cities to serve their respective communities.

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[8] David D. Owen: Report of a Geological Exploration of Part of Iowa, Wisconsin, and Illinois . . . in . . . 1839, Washington, 1844, p. 145.

Southeastern Wisconsin

Southeastern Wisconsin as a regional division has come to mean that portion of the state having the highest economic development and containing within its indefinite borders the major portion of the population. The region is not everywhere naturally delineated, nor has it the same combination of physical conditions over the whole area; but the distribution and the concentration of the inhabitants gives it sufficient unity to warrant regional analysis.

The northwestern boundary of this section of Wisconsin follows rather closely the frontier of 1850 and coincides roughly with the inner margin of a limestone upland that marks the boundary between the Central Lowland and the Eastern Ridges and Lowlands.[10] To the west the character of this region gradually changes until it merges into a landscape typical of the Driftless Area, within which the lead region is located. The Wisconsin glacier spread over most of the region, but toward the south there is a section of older drift with a more mature drainage development, and farther toward the southwest is an unglaciated section. The glacial landscape was generally forested, but in the southern tier of counties open prairies intermingled with woodland; and along the northwestern border of this province there were extensive openings. Door Peninsula and a strip along Lake Michigan as far south as Port Washington in Ozaukee County was pine-covered, but between the prairies and the pine forest was a great hardwood forest with maple the predominant wood. This was the landscape presented to the pioneers.

Within the region known as southeastern Wisconsin there were two early settlements. The one was Green Bay, the oldest city of Wisconsin, strategically situated near the mouth of the Fox River. In 1634 Nicolet, the first white man to visit Wisconsin, ascended the Fox River, which later became the natural route to this part of the Northwest. He had left the French settlements of the lower St. Lawrence, ascended Ottawa River, and skirted the shores of Lake Nipissing, Georgian Bay, and Lake Michigan into Green Bay. The orientation of these natural highways made Wisconsin accessible to the growing French colonies along the St. Lawrence. This became the much used highway of the fur traders and explains the predominant French influence in Wisconsin for more than a century before the territory was lost to the British. It is only logical, then, that Fort Howard at Green Bay was selected as a military post. By 1820 when the lead region of Wisconsin began to be penetrated by the miners, there was already a settled community at Green Bay. There were ". . . about sixty houses with a population of perhaps 500 souls, besides which was a garrison."[11]

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[9] S. L. Schubring: A Statistical Study of Lead and Zinc Mining in Wisconsin, *Trans. Wisconsin Acad. of Sci., Arts, and Letters*, Vol. 22, Madison, 1926, pp. 9–98.

[10] Lawrence Martin: The Physical Geography of Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 36, Educ. Ser. No. 4*, 1916, p. 30.

The *voyageurs* who ascended the Fox River penetrated into the interior of Wisconsin by portaging across the narrow land bridge to the Wisconsin River. The modern city of Portage now marks this strategic site, once defended by a military post at Fort Winnebago. The fort was erected in 1828, at the request of the American Fur Company to prevent the Indians from exacting toll from the traders who wished to portage from the Wisconsin to the Fox River. To these two early settlements should be added Fort Crawford, the site of which is now occupied by Prairie du Chien at the junction of the Wisconsin with the Mississippi River.

It was not until after 1832, when the danger of hostile Indians had been ended by the brief struggle commonly referred to as the Black Hawk War, that the southeastern part of the state was open to settlers.[12] This frontier struggle and the hard times in eastern cities combined to stimulate a new wave in western migration, appropriately called the Jacksonian migration.[13] Wisconsin's choicest section was then ready for settlement.

According to the census of 1830, there were 964 people in Brown County, and most of these were in the vicinity of Fort Howard at Green Bay. Six years later at the time of the Territorial Census there were 2706 in the county, or about 24 per cent of the 11,683 reported for the territory. Milwaukee County had 2893 inhabitants; and so southeastern Wisconsin exceeded the southwestern region by only a few hundred souls.

The newcomers distributed themselves over southeastern Wisconsin as a thin film of population, entering first of all the better lands in the southern tiers of counties where the open prairies offered attractive conditions to the pioneer. Where the prairies were too extensive the central portions remained unoccupied for a few years. The borders of the prairies offered an ideal combination of a woodland for fuel and building material with a prairie area for plowland.[14] Most of the land

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[11] Frederick J. Turner: The Character and Influence of the Fur Trade in Wisconsin, *Proc. 36th Ann. Meeting State Hist. Soc. of Wisconsin*, 1889, pp. 52–98; reference on p. 92.

[12] Joseph Schafer: Four Wisconsin Counties, Prairie and Forest (Wisconsin Domesday Book, General Studies, Vol. 2), Madison, 1927, p. 52.

[13] Paxson, *op. cit.*, pp. 286 and 312.

[14] Joseph Schafer: A History of Agriculture in Wisconsin (Wisconsin Domesday Book, General Studies, Vol. 1), Madison, 1922, p. 36.

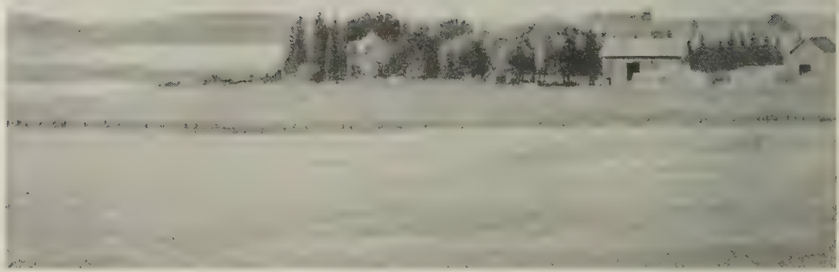


FIG. 7

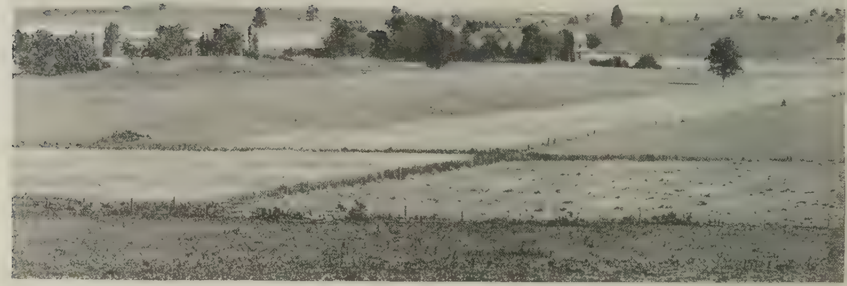


FIG. 8

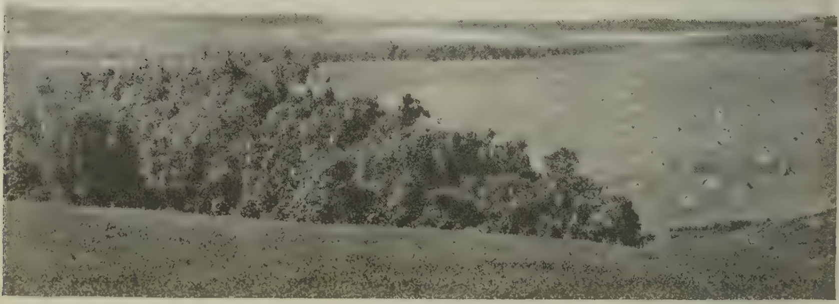


FIG. 9

FIG. 7—A typical prairie landscape in southern Wisconsin showing a farmstead protected by the characteristic exotic trees. (Courtesy of the Wisconsin Soil Survey.)

FIG. 8—A view showing the use made of gently rolling glacial landscape in eastern Wisconsin, where the favorable land conditions are the bases of the high agricultural development and the dense rural population. (Courtesy of the Wisconsin Soil Survey.)

FIG. 9—A portion of the limestone upland in western Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

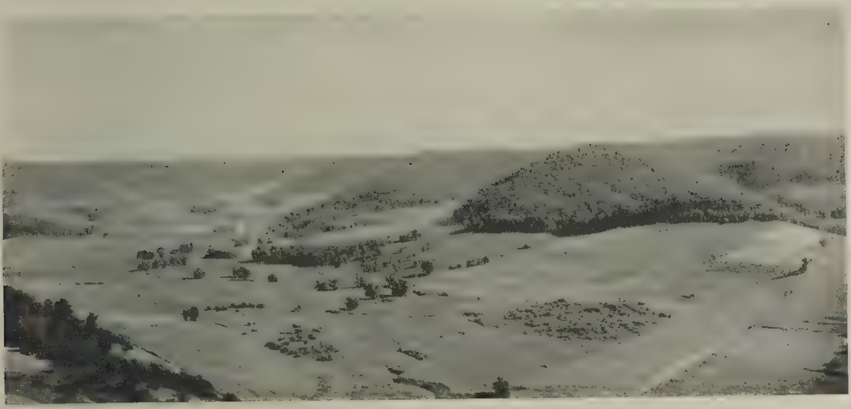


FIG. 10

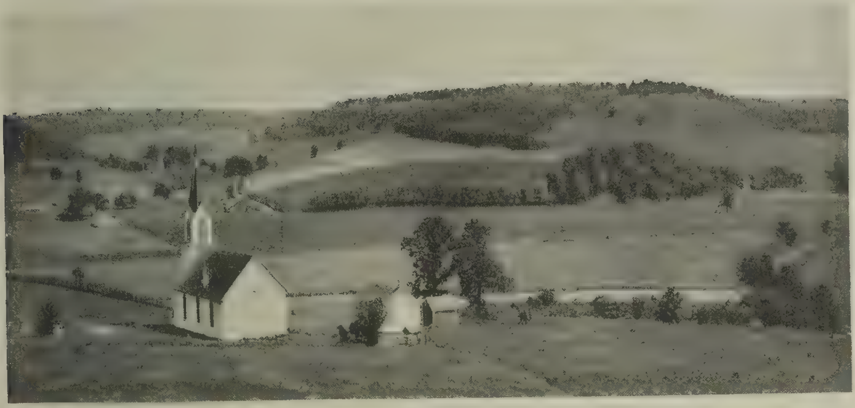


FIG. 11

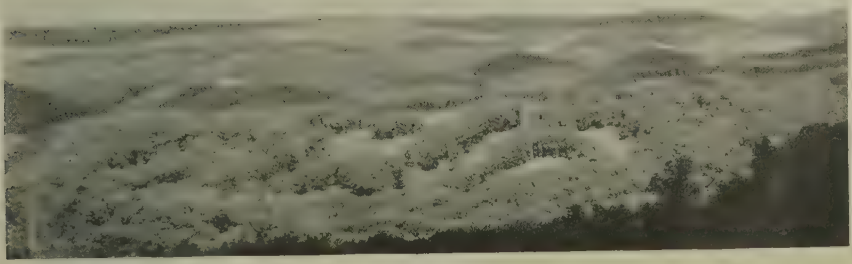


FIG. 12

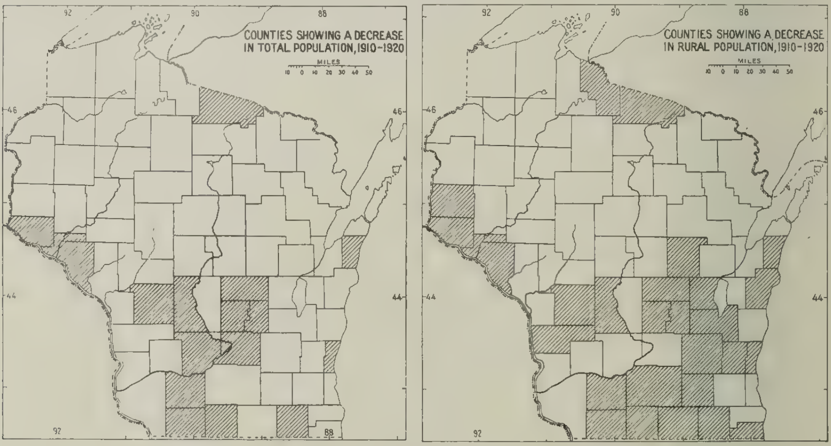
FIG. 10—Dutch Valley in La Crosse County represents one of the more open valleys of western Wisconsin permitting a fair agricultural use of the land. (Courtesy of the Wisconsin Geological Survey.)

FIG. 11—A characteristic scene in the rugged section of western Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

FIG. 12—The eastern margin of the Western Upland is distinctly rugged, making agriculture difficult. (Courtesy of the Wisconsin Geological Survey.)

was entered in the late thirties in the southeastern corner of the state, but settlement did not occupy all of this section until two or three decades later. In 1840 the lead region had about 8000, and the much larger and newer southeastern section had approximately 18,000 people.

By 1850 the frontier had reached the Fox-Lower Wisconsin rivers, and a vanguard had pushed beyond into a newer and a different country. The rather uniform distribution of people over the settled portion of the state indicates equal land values. The pine-covered Door Peninsula and Manitowoc and Sheboygan counties effectively held back the frontier, while the dissected bluffs bordering the lower Wisconsin and Mississippi rivers imposed an obstacle to the conquering pioneers.


COUNTIES SHOWING A DECREASE IN TOTAL POPULATION, 1910-1920
MILES
10 0 10 20 30 40 50
92
90
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46
44
COUNTIES SHOWING A DECREASE IN RURAL POPULATION, 1910-1920
MILES
10 0 10 20 30 40 50
92
90
88
46
44

FIG. 13

FIG. 14

FIGS. 13 and 14—Cartograms of Wisconsin counties showing decline in total and rural population between the censuses of 1910 and 1920.

The southeastern region was destined to become the most densely populated section of the state. The large-scale dot maps show clearly the distribution and the intensification behind the frontier. The more southern counties were completely occupied by 1870. Except for a small increase in the rural population in drainage areas and in the neighborhood of cities, the agricultural population has changed but little in the last fifty years.

Because of their national predisposition to take small farms of forty to eighty acres, the most densely settled rural areas are to be found in the sections north and west of Milwaukee occupied by German immigrants. In many areas the number of rural inhabitants is nearly 50 per square mile, or almost twice as great as the density of some of the characteristic counties of the Western Upland.

The principal population changes are reflected in the growth of cities and villages concomitant with changes characteristic of the United States as a whole. By 1900—and in certain communities even earlier—there was a withdrawal of people from the farms. Of the twenty-two modern counties in the section described as southeastern Wisconsin, at least fourteen showed a decrease in rural population from 1910 to 1920, and six showed a decrease in total population in the same period (Figs. 13 and 14). It is within this section that urbanization has been important. Along the lake shore Milwaukee, the metropolis of the state, Racine, Kenosha, Sheboygan, Manitowoc, and Two Rivers have shown rapid growth since 1900. Another chain of urban centers is located in the Fox-Winnebago lowland, including Green Bay, Kaukauna, Appleton, Menasha, Neenah, Oshkosh, and Fond du Lac. Milwaukee alone had within its corporate limits over 17 per cent of the total population of the state. This process of urbanization has offset the agricultural settlement of the new lands in northern Wisconsin, and the center of population has moved eastward and southward in the two decades since 1900.

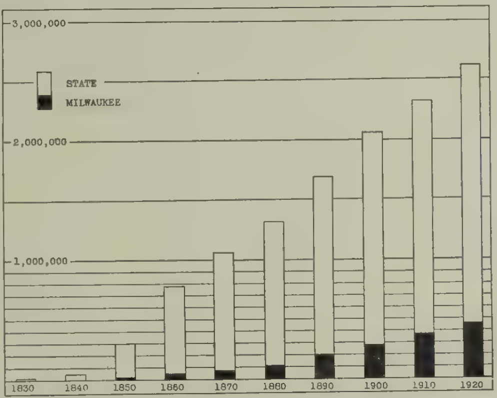

FIG. 15—Graph showing the growth of population in Wisconsin.

THE WESTERN UPLAND

The lead region already described lies within the Western Upland. The three lead counties of Grant, Iowa, and Lafayette include within their borders a portion of a limestone cuesta-upland south of the lower Wisconsin River. The topography is a gently undulating upland except along the Wisconsin and Mississippi rivers where the labyrinth of streams has dissected the area into rugged relief. The back slope preserves the upland character except locally where the streams have incised themselves to a depth of a hundred feet or more into the underlying sandstone.

To the north of the lower Wisconsin, the Western Upland assumes its characteristic ruggedness. Most of this section is within the Driftless Area, but the northern portion was covered by a pre-Wisconsin glacier. Even here the effects of the drift have been largely erased, until the line that marks the northern boundary of the Driftless Area is more or less obscure and is traced with difficulty. This is the most rugged section of Wisconsin and may be simply described as a maturely dissected plateau having a relief of 300 to 500 feet. Locally the capping limestone has preserved wide interstream areas well suited to intensive agricultural development. This is true of both the northern and southern portions. The central division traversed by the La Crosse, the Black, and the Trempealeau rivers is in late maturity, and the ridges are too narrow for especial agricultural use. Originally the region was covered by a hardwood forest except for a strip of prairie land along the uplands in Crawford and Vernon counties.

In 1850 there were about 9000 people in that part of the Western Upland beyond the lower Wisconsin. An examination of the maps will show that there was a wave of settlement that progressed northwestward across the upland. The more southern counties were settled in the decade of the fifties, the central portion in the sixties and seventies, and the more northern region in the seventies and the eighties.

It is evident that the hilly Western Upland did not retard settlement, but its ruggedness has kept the density of the rural population below that of the southeastern part of the state. Vernon County, which lies across the upland and represents a well dissected portion, may be considered as characteristic. The county is essentially rural, having only one city with a population exceeding 2500. In 1880 Vernon had a total of 23,235 inhabitants, or 28.3 per square mile; in 1900 there were 28,351, or 34.5 per square mile; and in 1920 there were 29,252, or 35.6 per square mile or only 32.5 per square mile if simply the rural population is considered. In southeastern Wisconsin, Dodge County may be selected as representative of the densely populated region. In 1900 Dodge County had 41.5 rural inhabitants per square mile, but by 1920 this had been reduced to 37.2 persons per square mile. Sheboygan in 1920 had 49.0 rural inhabitants per square mile. It is obvious that the ruggedness of the topography and the small proportion of arable land available for farms have prevented a dense rural population. However, the development of the dairy industry, which permits a profitable use of the steep slopes for pasture, has permitted a comparatively high economic development.[15] But the ruggedness of the landscape has imposed a barrier to communication, and the consequent isolation has had its retarding effects.

Furthermore, the Western Upland lies on the wrong side of Wisconsin to benefit from the commercial activities dominant along Lake Michigan and so is handicapped under modern economic conditions. It is doubtful if the Mississippi River, developed into an important waterway, could stimulate more than a slight awakening of certain cities that are strategically situated, as for instance La Crosse and Prairie du Chien.

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[15] G. T. Trewartha: The Dairy Industry of Wisconsin as a Geographic Adjustment, *Bull. Geogr. Soc. of Philadelphia*, Vol. 23, 1925, pp. 93–119.

The Central Plain

This crescent-shaped area underlain by the weak Cambrian sandstone is a conspicuous physiographic region in the central part of Wisconsin. Toward the northwest it narrows and becomes a transitional zone between the Western Upland and the Northern Highland. The northeastern portion was recently glaciated, and the thick mantle of drift has obscured the underlying sedimentary formations. Furthermore, the pine forest made the area much like the glaciated portion of the Northern Highland and in a similar way has retarded the agricultural invasion of the area.

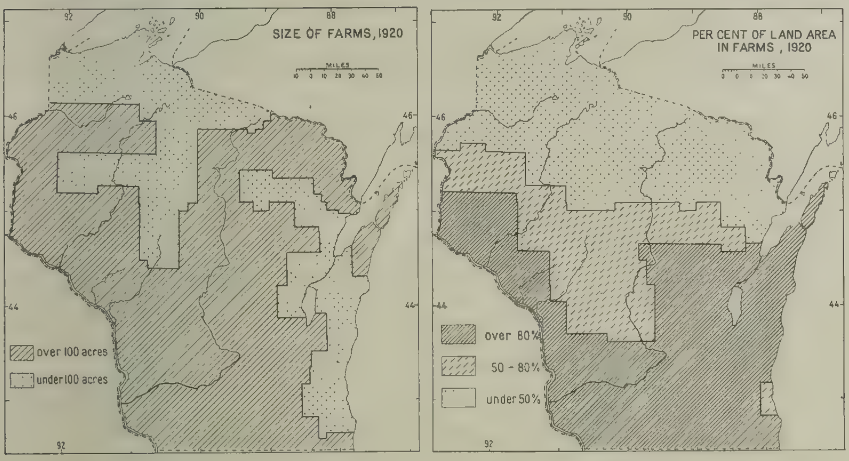

Fig. 16

Fig. 17

Figs. 16 and 17—Cartograms showing the size of farms and the percentage of land in farms in Wisconsin (1920).

The portion of the Central Plain that may be considered typical lies within Clark, Jackson, Wood, Juneau, Adams, Portage, Waushara, and Marquette counties. Its geological boundaries are blurred, especially along the eastern border where glaciation has affected the area. The region is relatively infertile, offering only slight opportunities for agriculture. It was the first barrier to the settlement of the land to the north.

Adams County may be chosen as representative of the unglaciated portion of this sandy lowland. In 1850 there were only 187 people in the county, but ten years later there were 6492. Three successive decennial enumerations show almost a static population; but in 1900 there were 9141, and in 1920 the largest population was recorded—a total of 9284. That is 13.6 per square mile, or less than a third of the density of the rural population of Washington County in the southeastern part of the state. A large part of Juneau, eastern Jackson, and southern Clark counties is similar in physical conditions to Adams

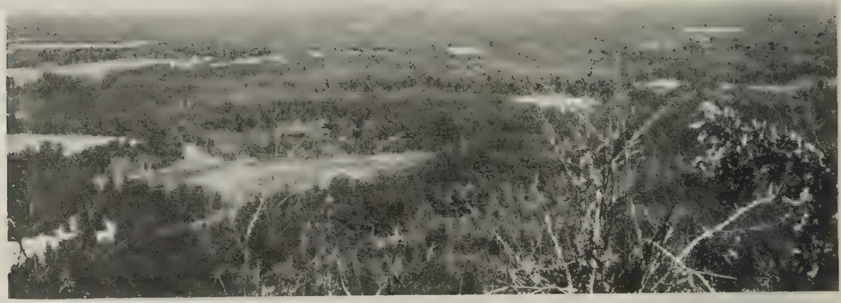

Fig. 18

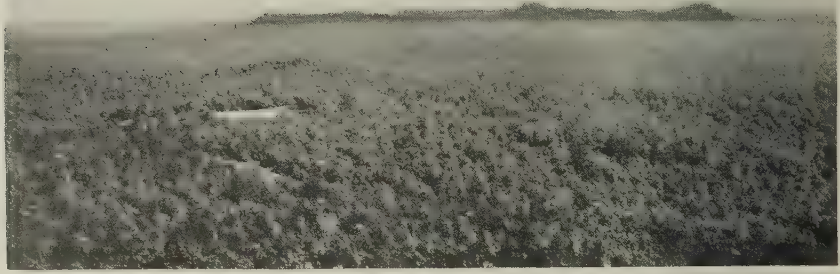

Fig. 19

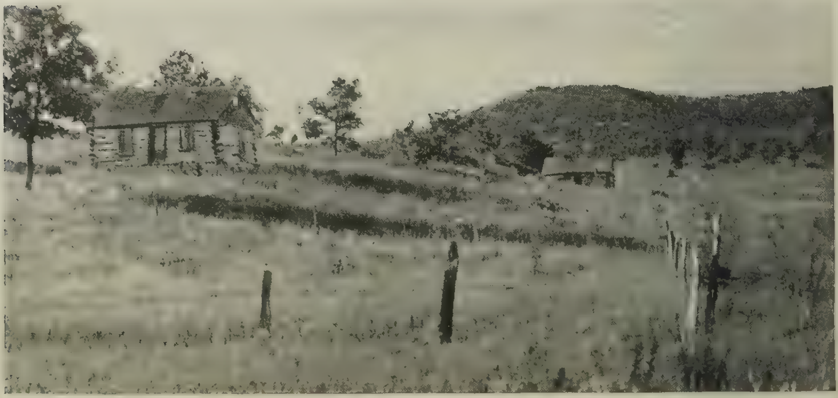

Fig. 20

Fig. 18—A characteristic view of the sandy Central Plain. The small amount of cleared land is evidence of its low value. (Courtesy of the Wisconsin Geological Survey.)

Fig. 19—Waste land of the Central Plain. The wood will hardly pay for cutting, and the land is not worth clearing. (Courtesy of the Wisconsin Geological Survey.)

Fig. 20—An abandoned farm along the western margin of the Central Plain. (Courtesy of the Wisconsin Geological Survey.)

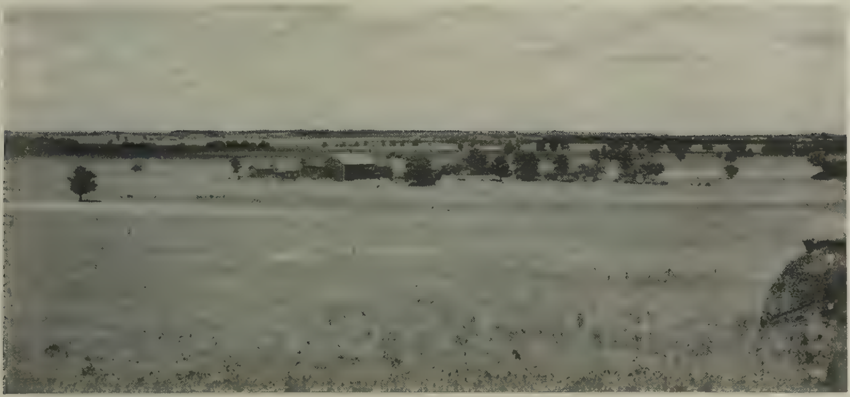

FIG. 21

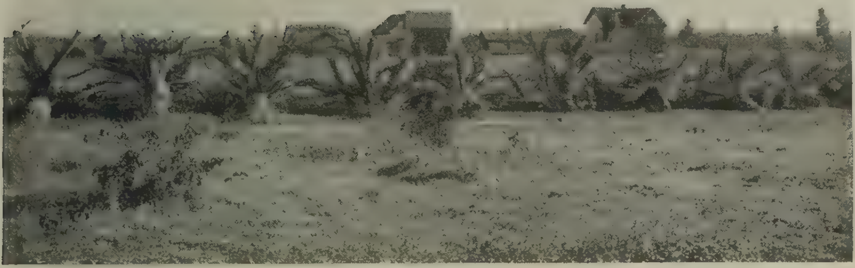

FIG. 22

FIG. 23

FIG. 21—An outer moraine and an outwash plain in eastern Portage County. The favorable topography is offset somewhat by the light soils. (Courtesy of the Wisconsin Geological Survey.)

FIG. 22—Pine stumps used for a fence on one of the newer farms in central Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

FIG. 23—This view illustrates the success of the pioneers in conquering the wilderness of northern Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

County; and the density of population is similar and directly related to the low intrinsic value of the land (Figs. 18, 19, 20).

To the east of Adams County lies Waushara, almost wholly within the glaciated area. Both counties are underlain by the Cambrian sandstone, but across Waushara the Wisconsin glacier spread a veneer of drift in which are mixed limestone and igneous boulders. The decomposition of this heterogeneous mixture has produced a soil superior to that in Adams County (Figs. 21 and 22). The population of Waushara County from 1860 to 1910 has shown a steady increase. The 1920 census showed a decrease of 11.5 per cent; but the density was 25.8 per square mile, almost double that of Adams County.

The sandy central lowland has patches of silt soils within larger areas of sand, and a few farmers who were fortunate in the location of their farms are reasonably prosperous. There are, however, hundreds of farmers who have abandoned their farms after a few years' trial, and recently the question of unpaid taxes has become serious.

The belt of sand country that attracted the pioneer because it was level is of doubtful value. Farmers bought land here and failed, and later the process has been repeated in the same area. As previously stated, the sand plain became a barrier to the settlement of the superior farm land to the north of it.[16]

NORTHERN WISCONSIN

The westward march of the frontier across the United States "passed by" northern Wisconsin. In the seventies the population of the state increased 260,827, or 24.7 per cent; Iowa showed an increase of 430,595, or 36.1 per cent; and Minnesota added 341,067 to her population, a gain of 77.6 per cent. It is evident that the advance into Wisconsin had been slowed down. The northern part of the state lies off the principal highways followed by the home seekers. Furthermore, the prairies to the west offered greater opportunities to agriculturists than did the heavily forested land to the north.

In northern Wisconsin there has been preserved a part of the frontier, while the southern part of the state has experienced an intensification of population by the process of urbanization comparable to the general trend in the eastern United States. This combination of frontier and settled sections has produced a regional division of inhabitants on some of the economic problems of the state, as for example, the conservation movement.

Just as the fur trader pioneered into the wilderness of northern Wisconsin, the lumbermen with ax and saw overlaid a new industry on the site of the old. The settlement of the treeless prairies of the

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[16] John D. Black and L. C. Gray: Land Settlement and Colonization in the Great Lakes States, *U. S. Dept. of Agric. Bull., No. 1295*, Washington, 1925, p. 12.

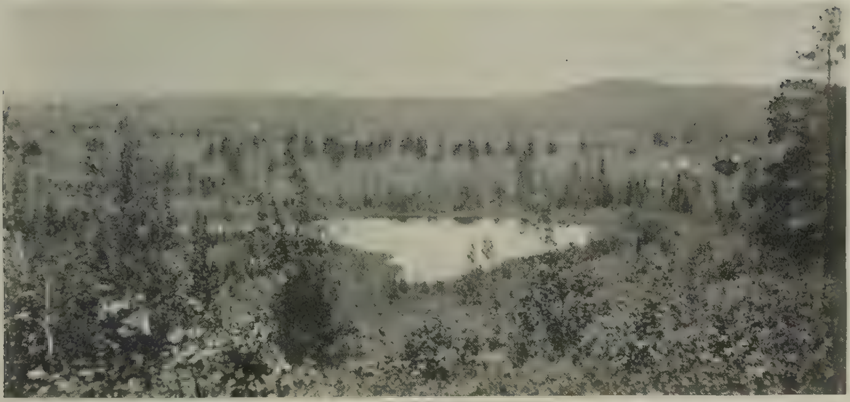

FIG. 24

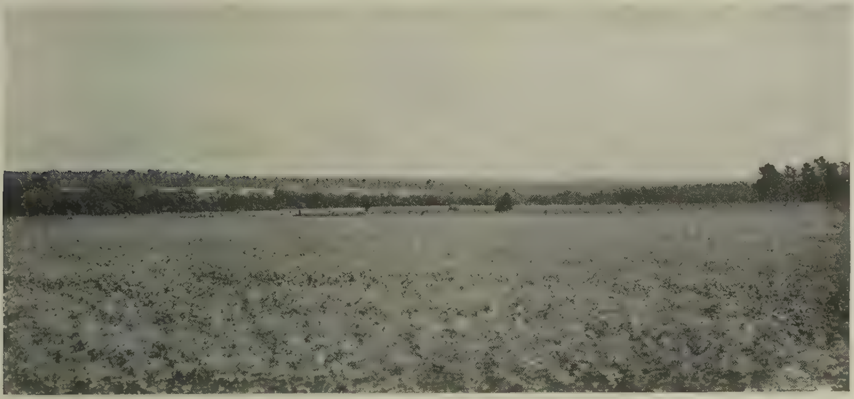

FIG. 25

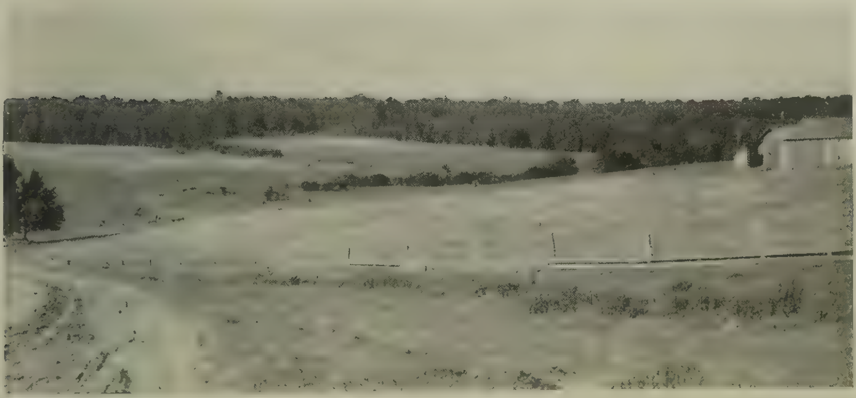

FIG. 26

FIG. 24—A landscape that can effectively hold back the encroaching agricultural frontier. (Courtesy of the Wisconsin Geological Survey.)

FIG. 25—A portion of the ancient peneplain in Marathon County. The heavy soil of this section of the unglaciated Northern Highland is the basis of a prosperous agricultural community. (Courtesy of the Wisconsin Geological Survey.)

FIG. 26—A more dissected portion of the peneplain in Marathon County. The characteristic hardwood forest is well represented. (Courtesy of the Wisconsin Geological Survey.)

upper Mississippi Valley created a demand for lumber which the forests of Wisconsin and adjacent states were made to supply. The Mississippi and Wisconsin rivers and their tributaries not only drained the water from pine-covered northern Wisconsin but drained the lumber as well into the prairie states. About 1870 the industry took on the qualities of a lumbering boom. "For forty years lumbering was the dominant interest in the northern half of the state. Into the pineries every winter went small armies of men. Down its rivers every spring the river-men drove thousands upon thousands of pine logs. Along these rivers hundreds of saw mills stood. Around the mills grew up the lumbering towns."[17] Contemporaneous with the development of the lumber industry, and necessary to its successful prosecution, the railroads threaded their way northward toward Lake Superior. By 1871 the Wisconsin Central reached Stevens Point and in 1877 was completed to Ashland. Extensions and so-called "logging roads" brought the pinery within the pale of the lumber market.

In northern Wisconsin the advance of the series of frontiers did not follow either in point of time or in type the sequence in southern Wisconsin. The frontier of the hunter and the trader had a longer lease of life and reluctantly gave way before the cutting edge of the lumberman's frontier. For almost half a century the pioneer woodsmen extended their salients up the rivers and later along the railroads until the primeval forest was separated into isolated areas of unconquered pine.

The destruction of the forest did not leave in its wake farm land of such high potential value as in the hardwood areas to the south. The idea, and perhaps the need, of conservatism came too late to save a part of the forest on land unsuited for agriculture (Fig. 24). Because of the lack of easily cultivated prairies, the low intrinsic value of the land, and the severer climatic conditions, the agricultural frontier passed very lightly across the northern part of the state leaving in its wake only a sparse population (Figs. 1 and 23).

Under the stimulus of the historical westward migration land-hungry farmers, assisted by none-too-scrupulous colonizers, have settled upon marginal land and under the discouraging economic conditions that have robbed them of their anticipated rewards have lost their ambition and become marginal farmers. There are too many farmers in northern Wisconsin who have failed in their effort to accumulate more than the mere necessities of life. The State Bureau of Immigration is working toward the placement of pioneers upon farm land that will yield them a fair reward for their efforts and is preventing land companies from selling poor land to newcomers who do not fully appreciate the hardships of the pioneer.

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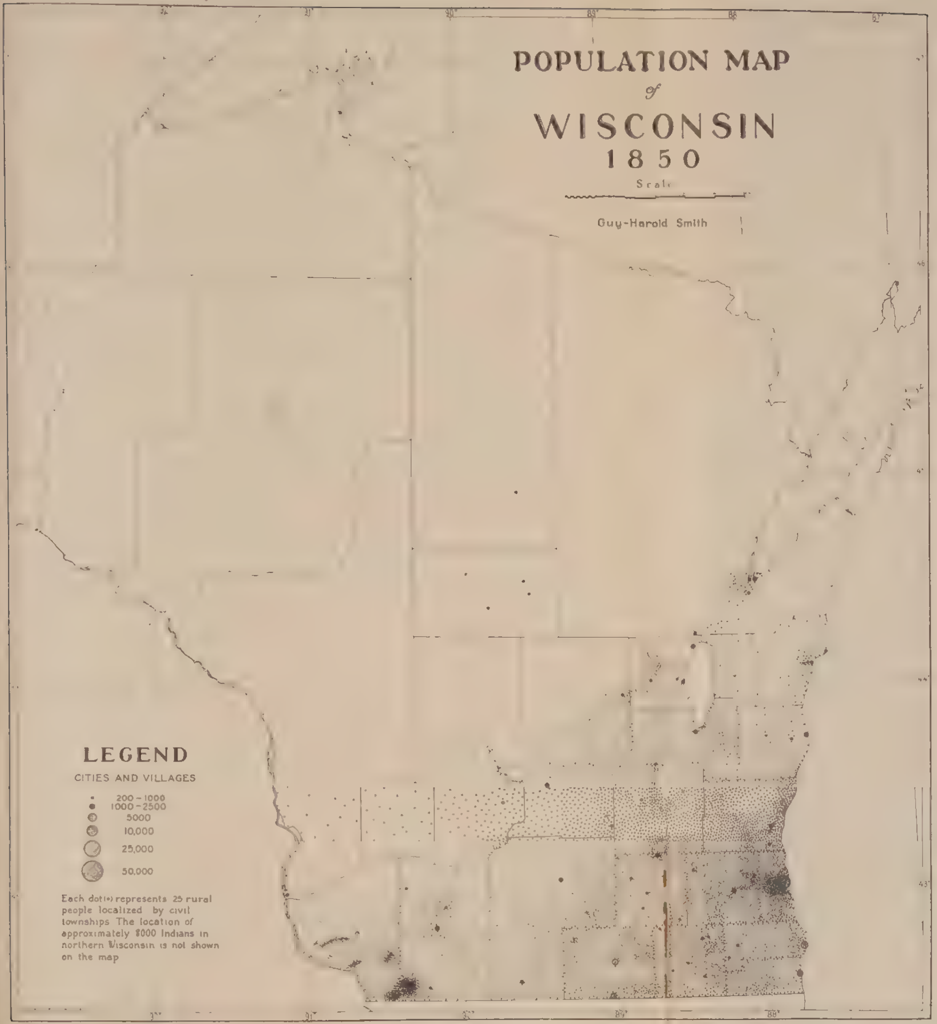
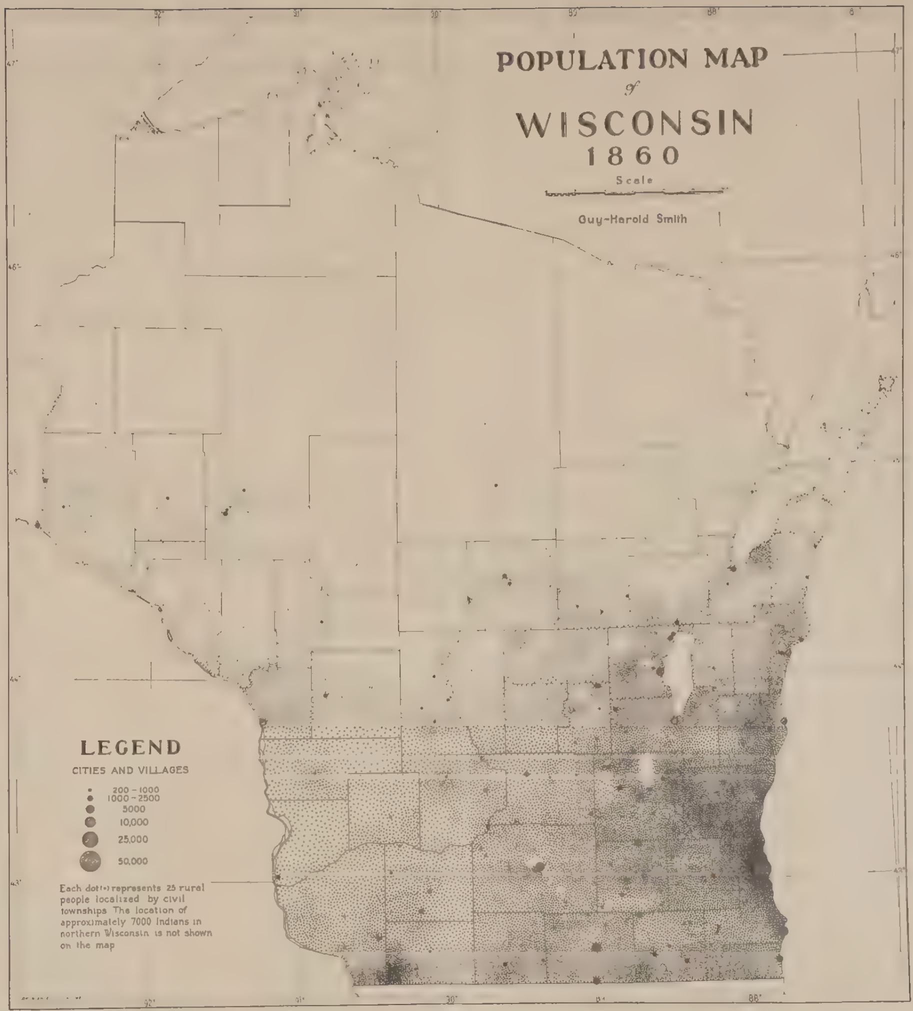
[17] R. H. Whitbeck: The Geography and Industries of Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 26, Educ. Ser. No. 3*, 1913, p. 20.



Each dot(•) represents 25 rural people localized by civil townships The location of approximately 8000 Indians in northern Wisconsin is not shown on the map



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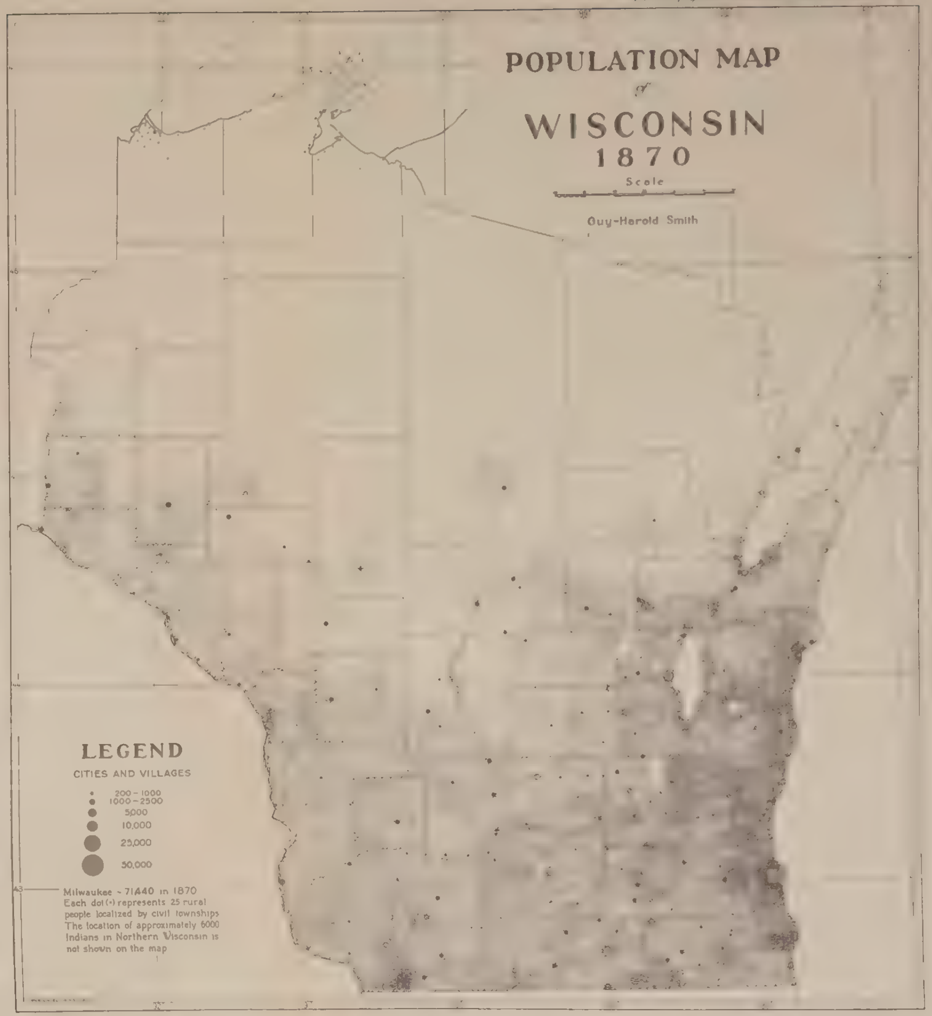
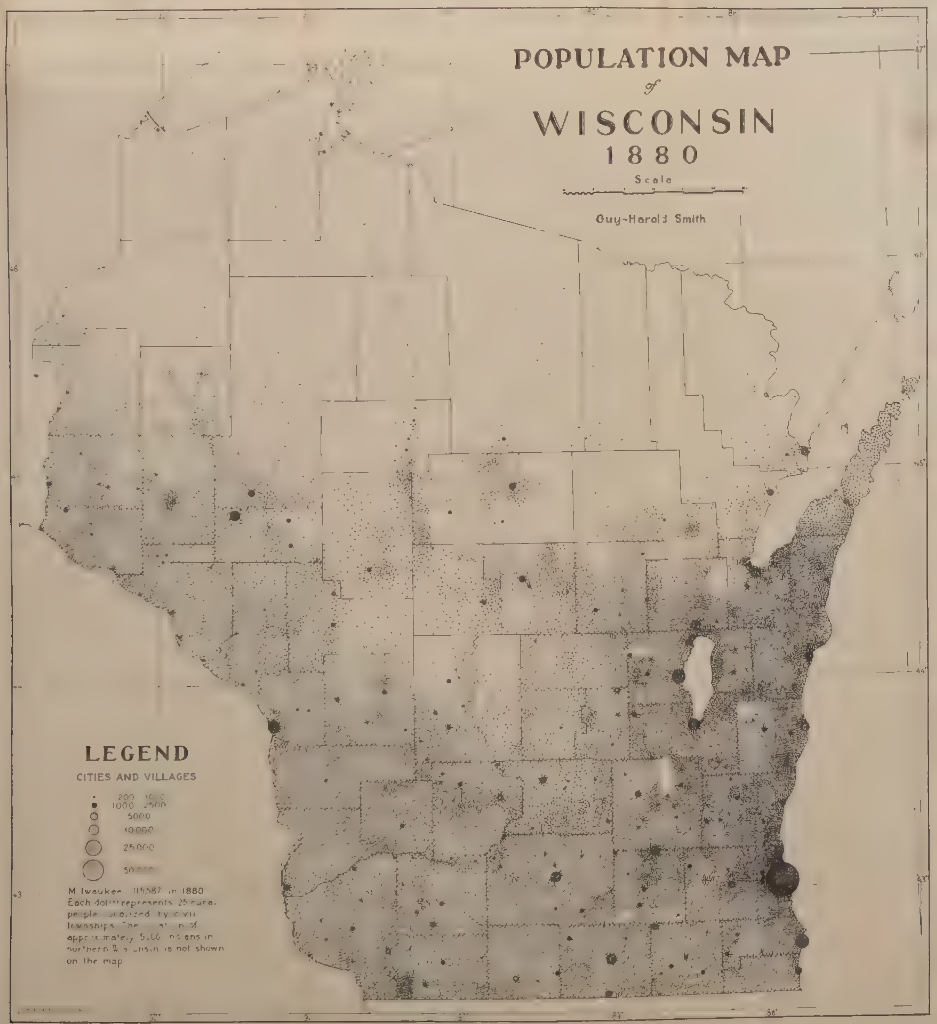
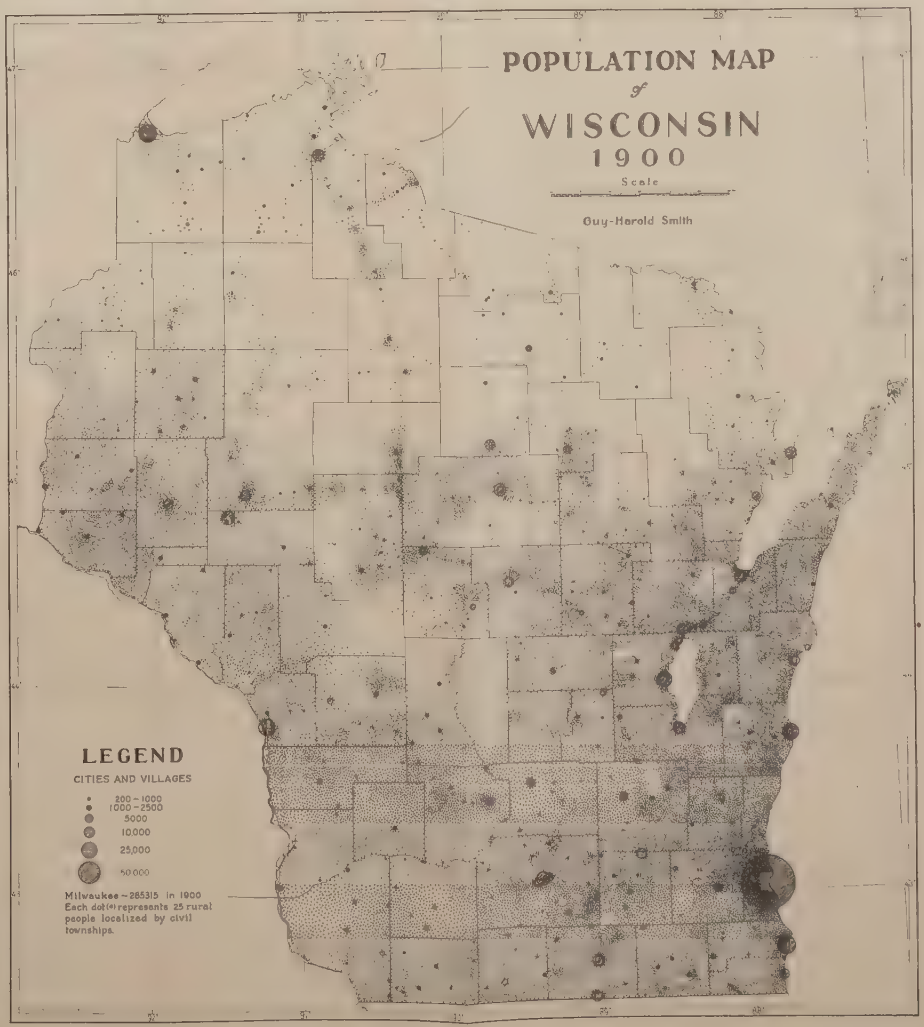


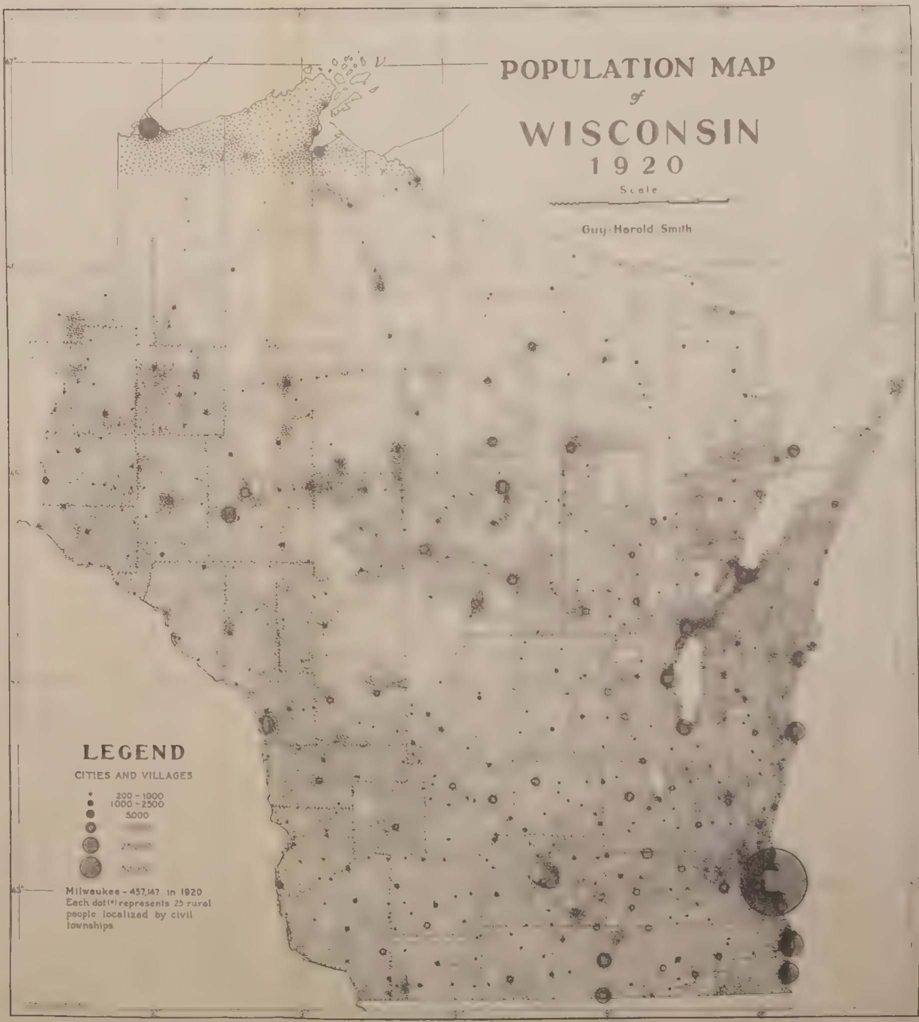
Milwaukee – 71440 in 1870
Each dot(•) represents 25 rural people localized by civil townships The location of approximately 6000 Indians in Northern Wisconsin is not shown on the map



Milwaukee – 115587 in 1880
Each dot(•) represents 25 rural people localized by civil townships The location of approximately 5000 Indians in northern Wisconsin is not shown on the map



Milwaukee – 285315 in 1900
Each dot(•) represents 25 rural people localized by civil townships.



Milwaukee – 457,147 in 1920
Each dot(•) represents 25 rural people localized by civil townships.

A. Hoen & Co.

Northern Wisconsin is a mosaic of various types of soil with patches of land of high intrinsic value located between, and in some places surrounded by, extensive sandy or rocky areas unsuited for agricultural development. The northward movement expended itself on the settlement of the sedimentary portion of Wisconsin and the southern segment of the crystalline highland.

The eight counties that occupy the crescent-shaped area along the southern border of the Northern Highland have a total area somewhat less than the remainder of the region. However, there is an outstanding difference in the number of people in the two areas. In 1880 the border counties had a total of 89,516 as compared with the 11,710 for the more northern counties; by 1900 the population in the border counties had increased to 222,790 and the northern counties to 161,698; and in 1920 the larger and more northern area was approaching the 293,452 of the border counties but still fell several thousand short with 260,743 inhabitants. The rapid growth of the population along the edge of the crystalline upland is reflected in the increase of land in farms and a concomitant increase in improved land (Figs. 25 and 26).

Around the crescent-shaped border of the Northern Highland the woodland is being requisitioned for farm land. The value of the northern lands has been grossly overestimated; but a truer valuation deserves to be more widely circulated among prospective home seekers than it has been. It is estimated[18] that "forty per cent of our cut-over land is unsuited to farming . . ." Progress northward will continue but should be guided by an intelligent selection of farm land that leaves the poorer areas for forests and resorts.

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[18] B. G. Packer and Oscar Gunderson: Preliminary Biennial Report of the Wisconsin Department of Agriculture, Immigration Division, Madison, 1923–1924, p. 45.

A POPULATION MAP OF OHIO FOR 1920

Guy-Harold Smith
The Ohio State University

[With separate map, Pl. IV, facing p. 426]

THE method of representing distributional phenomena by dots is common enough to make an additional effort seem commonplace. But the accompanying map of Ohio, based on the census of 1920, is more than a dot map. The writer has attempted, by the use of a sphere-like symbol, to show not only the distribution but the concentration of people in compact communities. The experiment is not a new one, for Sten De Geer has used the same method in his population studies in Scandinavia.[1] He used dots to show both the distribution of the rural inhabitants and the location of the small urban communities. The latter were distinguished from the former by the symmetrical arrangement of the dots. This made it easy to determine approximately the population of the smaller towns. The larger cities were represented by appropriate symbols so shaded as to resemble spheres. This is the device borrowed by the writer and modified in the making of the Ohio map.

CONSTRUCTION OF THE MAP

In the formula for the volume of a sphere, $\frac{4}{3} \pi R^3$, the only variable is the radius. This was quickly computed for each symbol by the use of an engineer's slide rule and a proportional scale. The smaller cities and villages were grouped in two divisions. The United States census regards as "rural" all cities and villages having a population of less than 2500, but on the Ohio map all incorporated places with a population of more than 200 have been shown as urban "agglomerations." As stated in the legend, a small sphere in solid color was chosen to represent all cities and villages having between 200 and 1000. A larger but approximately proportional sphere represents cities and villages having between 1000 and 2500.

All cities of more than 2500 population were regarded as individuals in order to make the symbols correspond more or less exactly with the census data. The larger symbols were drawn in perspective by the use of meridians and parallels. In order to accentuate the optical illusion and make the symbols appear more nearly like spheres, the light was regarded as coming from the upper left or northwest. The lower right or southeastern part of the symbols was darkened to give the effect of being in shadow.

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[1] See Sten De Geer: A Map of the Distribution of Population in Sweden: Method of Preparation and General Results, *Geogr. Rev.*, Vol. 12, 1922, pp. 72–83. See also Ellsworth Huntington's review of Sten De Geer's work, *ibid.*, Vol. 9, 1920, p. 360.

Each of the larger symbols represents an individual urban community, including in most cases the suburbs. But the cities of Cleveland and Cincinnati and their "satellite cities"—shining not only by the reflected economic light of the "parent sun" but by their own light—have been carefully drawn in order to picture the true conditions.

The dots, so called, are to be regarded as small spheres proportional in size to the larger symbols. As stated in the legend, the dots are localized by minor civil divisions. The boundaries are not shown, but a township map was used beneath the original to assist in the localization of the symbols. The topographic maps of the United States Geological Survey were consulted whenever they were found serviceable. Fortunately the Topographic Atlas has been completed for Ohio.

COMPARISON WITH THE WISCONSIN MAPS

There have been various criticisms of the three-dimensional symbols; but the principal objection to their use is the real or imaginary difficulty of visualizing comparative volumes. We may ask, however, if the Ohio map, Plate IV, does not convey as true a visual picture of the population conditions in Ohio as do the Wisconsin maps of the population of that state, Plate III (accompanying preceding article). In the Wisconsin series comparative circles were used to represent the cities. This device is quite familiar and is widely used. It is generally more acceptable than the use of the sphere-like symbol because it is a surface device shown on a surface.

The scale used on the Wisconsin map was chosen after a trial-and-error experiment. It seemed desirable to use a scale that would keep the area of the circles comparable with the corporate area of the cities. This, obviously, was impossible; hence it was necessary to compromise. The circles were drawn on a scale that promised to give a fairly accurate picture of the population conditions they were intended to show. By the use of thin lines the circles became transparent discs through which could be shown the boundaries of the larger and important cities and the intensification of the rural inhabitants adjacent to the cities. Because of the inherent difficulty in drawing transparent spheres, this desirable feature of the Wisconsin series of maps could not be used on the Ohio map.

On the Wisconsin maps the areas of the dots used to show the distribution of the rural inhabitants are not exactly comparable with the larger circles. This means that a symbol on one scale was used to depict the dispersion of the rural inhabitants, and the same symbol on a different scale was used to show the population agglomerations. As on the Ohio map, the dots were localized by civil townships; and the merits of the scheme are obvious.[2]

Rural and Urban Population of Ohio

The active settlement of Ohio began in the last decade of the eighteenth century. The census of 1800 gave a population of 45,365. The population increased rapidly until about 1850 when the rate of increase was slightly reduced for a few decades. In 1840 Ohio attained third place among the states, being exceeded by New York and Pennsylvania. In 1890 third place was relinquished to Illinois, and since then Ohio has been fourth in population. In the decade from 1910 to 1920 Ohio added almost a million to its population, an increase of 20.8 per cent as compared with the increase of 14.9 per cent for the United States as a whole.

This increase, which was due in part to the industrial expansion induced by war conditions, was slightly less than the increase in the urban population alone, which means that there was a reciprocal decrease in the rural population. The position of Ohio between the east and the west and its favorable situation as regards the iron ore and coal resources have contributed to the rapid economic development and the growth of cities.

The first pioneers came into Ohio from the southeast across the rugged plateau; and Cincinnati, strategically situated near the bend of the Ohio River, became an important river town when the Ohio was one of the commercial highways of the Middle West. The city's early lead was not relinquished until near the end of the last century, but by 1920 Cleveland had almost twice as many people as Cincinnati. To these two largest cities in the state can be added five more, each of which had in 1920 a population of 100,000 or more. These seven cities of Cleveland, Cincinnati, Toledo, Columbus, Akron, Dayton, and Youngstown had a combined population of 2,171,635, or 37.7 per cent of the total for the state, a few thousand more than the total rural population.

Even as late as 1890 Ohio was still an agricultural state, but the industrial development was beginning to have its effects upon the rural population. From 1890 to 1900 the rural element in the population declined from 59.0 per cent to 51.9 per cent. At the turn of the century urbanization had not quite succeeded in reducing the rural population to a minority. In 1910, however, the rural population made up only 44.1 per cent, and by 1920 this was reduced to 362. per cent.

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[2] Compare Wesley Coulter: A Dot Map of the Distribution of Population in Japan, *Geogr. Rev.*, Vol. 16, 1926, pp. 283–284, and C. E. Batschelet: A Picture of the Distribution of Population in Pennsylvania, *ibid.*, Vol. 17, 1927, pp. 429–433.

Some Features of Regional Distribution

In southeastern Ohio is an extensive area of the Allegheny Plateau that was not covered by the continental ice sheet (Fig. 1). This section is slightly less rugged and more accessible than its remote counterpart in West Virginia and eastern Kentucky. As compared with the rest of Ohio where the relief is slight, the unglaciated plateau is more or less isolated except where lines of communication cross the area. Gallia County, for example, in the extreme southern part of the state, where the ruggedness of the landscape makes agriculture difficult, had in 1920 a total population of 23,311; and 6070 of these lived in the city of Gallipolis, a characteristic river town. In 1880 the maximum population was recorded. Vinton County also reached its maximum in 1880. In 1920 it had only 29.3 rural inhabitants per square mile, the lowest for any county in the state, while according to the census for 1925 it had an agricultural population of but 15.1 per square mile.[3]

The decline in the population in the rural sections of southeastern Ohio cannot be attributed entirely to the industrial expansion and the concomitant urbanization. This was the first part of Ohio to be settled by the pioneers who ascended the northern tributaries of the Ohio River. The better sections were cleared for crop land, but the steep slopes—except where extreme care prevented—were soon gullied and stripped of their soil with the result that the relative value of the land is the lowest in the state.[4] To agriculture itself must be attributed part of the reason for the decline in rural population.

Within the driftless portion of the state there are three or four areas where the density of population is greater than the average. These are mainly the coal-mining areas where the inhabitants engaged in mining are represented by the same sphere-like symbols, which, in effect, fill the interstices between those representing the agricultural peoples. In northern Jackson County is a small coal-mining area; and to the northeastward is the important Hocking Valley area, included within the counties of Hocking, Perry, and Athens. The population map shows a decided increase in density as compared with the surrounding agricultural region. These people are shown as rural, but they are not agricultural. They could not be shown as urban, for they live outside the corporate limit of the cities. The other coal-mining districts are in Noble and Guernsey counties and particularly in Belmont and Jefferson counties. Not only coal mining but the clay-using industries have contributed to the intensification of the non-urban population.

The change in density of the rural population from the driftless area northwestward into till plains is very gradual.[5] The gradient is difficult to visualize from the map, but it can be demonstrated statistically. In the northeastern part of the state Geauga County lies within the plateau just east of Cleveland. In 1920 the total population was 15,036, or 36.1 per square mile. The highest population was recorded in 1850 when the inhabitants numbered 17,827.

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[3] U. S. Census of Agriculture for Ohio, 1925.

[4] A. E. Waller: The Relation of Plant Succession to Crop Production, *Ohio State Univ. Bull.*, Vol. 25, No. 9 (Contribs. in Botany No. 117), Columbus, 1921, p. 71.

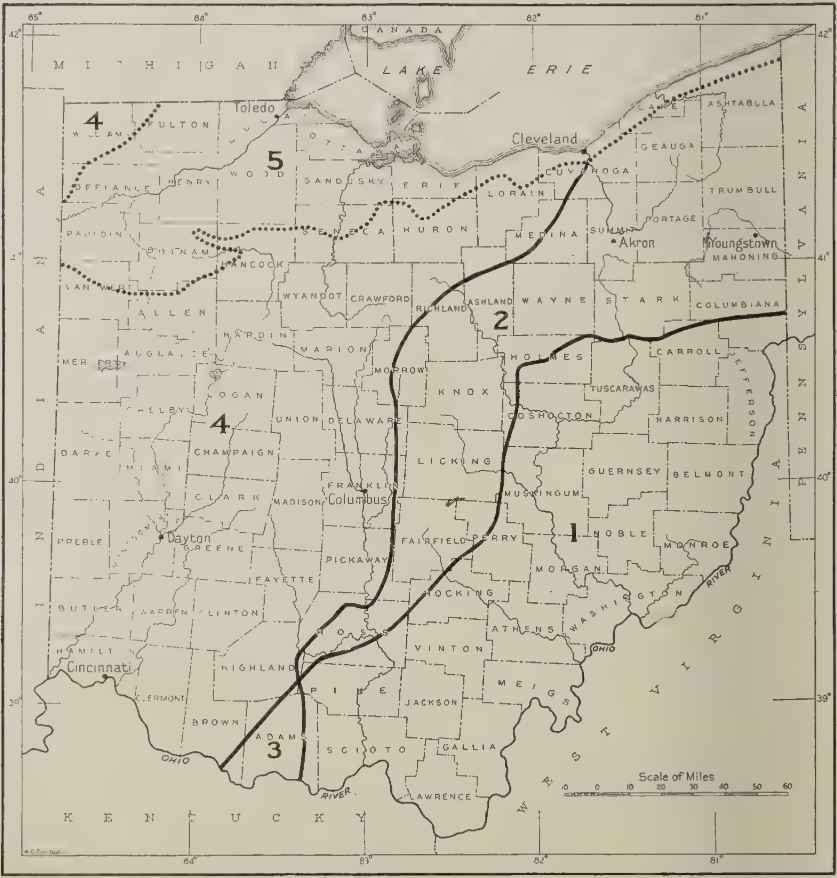

FIG. 1—The physiographic provinces of Ohio: 1, Unglaciated Plateau; 2, Glaciated Plateau; 3, Blue-Grass Region; 4, Till Plains; 5, Lake Plains. (After G. D. Hubbard, *Geol. Survey of Ohio Bull. 27, 4th Ser.*, 1923.) Scale approximately 1:3,750,000.

Morrow County, farther west on the border of the glaciated plateau and the till plains, had in 1860 a total of 20,445, the maximum recorded in any enumeration. Thereafter a steady decline brought the total down to 15,570 in 1920, a decrease of 23.8 per cent in sixty years. To be sure the decrease of the relief westward and northward from the driftless area is more favorable to agriculture, but the patches

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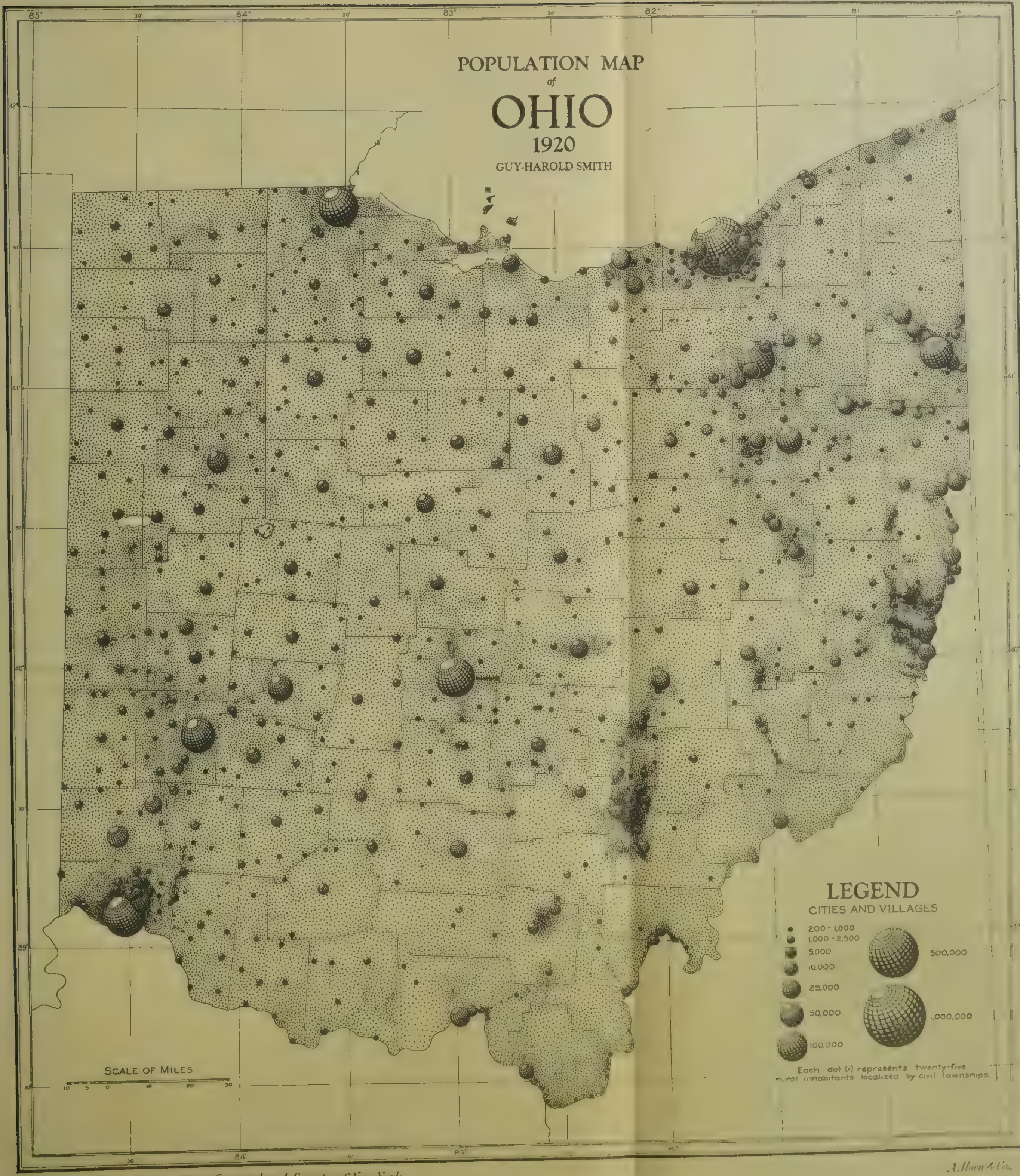
[5] Compare A. B. Wolfe: Some Population Gradients in the United States, *Geogr. Rev.*, Vol. 18, 1928, pp. 291-301.

The American Geographical Society of New York

The Geographical Review, Vol. XVIII, No. 3, 1928. Pl. IV



A. Hoen & Co.

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of poor soil and the wet areas still precluded the full use of the land and thereby hindered the growth of an agricultural population.

The map shows the area to the north of Cincinnati rather thickly settled. This part of Ohio was one of the first sections to be colonized, and from Cincinnati as a nucleus the frontier moved northward up the Miami Valley. It may be stated as a general fact that the older and strictly rural sections were completely occupied by 1880, and in individual counties the maximum was reached even earlier.

In northwestern Ohio lies the extensive plain of glacial Lake Maumee and its successors. The heavy soils of this area and adjacent sections of the till plains, and the reliefless character of the land made the area a vast swamp which retarded settlement. This was the last extensive area to be occupied by the pioneer. The earliest settlements were made along the well drained beaches of the receding waters of these ancient lakes.[6]

Most of the counties in northwestern Ohio did not reach maximum population until 1900 or even later. The counties containing cities of more than 10,000 have in most cases steadily increased, but the rural area reached a static condition about 1900. This area, like all other sections of Ohio, has experienced a decrease in rural population. The only notable exceptions are the zones about the larger cities where market gardening has intensified the use of the land and where unincorporated suburbs have become urban communities in rural territory.

The population map shows Toledo at the focus of a number of radial lines of communication, on which the cities and villages appear like "beads on a string." Along these radial lines and others that traverse the plain a hundred distances between cities were measured and averaged to find the spacing of these community centers. The average distance was found to be 7.3 miles. This number is very suggestive, for it raises the question of how many and how large cities an agricultural region can support.

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[6] Roderick Peattie: Geography of Ohio, *Geol. Survey of Ohio Bull. 27, 4th Ser.*, 1923, p. 10.

THE GATHERING OF FLOODS IN THE CONNECTICUT RIVER SYSTEM

J. W. Goldthwait

Dartmouth College

[With separate map, Pl. V, facing p. 444]

THE record-breaking floods of November 3–5, 1927, in New England, directed attention to problems never before fully faced by that region. Human suffering and loss of property in Vermont—and, in lesser degree, in New Hampshire—were promptly met by organized relief and reconstruction, thanks to experience acquired in the greater flood disasters of the Mississippi (1927)[1] and the Miami (1913).[2] In its scientific aspects, however, the New England flood was more of a novelty, for hitherto there had been no close, detailed study of a flood in a country with just that type of irregular glaciated surface. The systematic gathering and discharge of flood water in a simple, well organized river system like the Miami is necessarily different in kind as well as in size from the haphazard, disorderly behavior of an ungraded river system like the Connecticut. Partly because of this, and partly because the 1927 flood was so destructive as to warrant more than the usual analysis, as a measure of protection from future floods I undertook, as geologist of the New Hampshire Highway Department, to collect physical data and to carry on field studies in selected areas. Meanwhile, other organizations—railroads, power companies, groups of civil engineers, and meteorologists, each with a special emphasis and point of view—started investigations into the causes and consequences of this great flood. Some of the results obtained by the Highway Department have already been published in outline.[3] Other studies growing out of them are just beginning. The present paper is a brief discussion of the behavior of the flooded Connecticut River system, the largest of those affected and the one from which flood data have been collected with some fullness and, so far as I know, in a new form.

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[1] H. C. Frankenfield and others: The Floods of 1927 in the Mississippi Basin, *Monthly Weather Rev. Suppl. No. 29*, Oct. 18, 1927.

[2] See series of reports published by the Miami Conservancy District, Dayton, Ohio, 1917–1921, particularly: The Miami Valley and the 1913 Flood, by Arthur E. Morgan; Rainfall and Runoff in the Miami Valley, by Ivan E. Houk; and Storm Rainfall of Eastern United States, by the Engineering Staff of the District.

[3] J. W. Goldthwait and R. J. Lougee: Some Characteristics of Northern New England's 1927 Flood, *New Hampshire Highways*, Vol. 5, No. 9, Dec., 1927, pp. 1–6.

R. J. Lougee: Floods in New Hampshire, *New Hampshire Highways*, Vol. 6, No. 1, April, 1928, pp. 12–16; *idem:* Six Historic Floods, *ibid.*, Vol. 6, No. 2, May, 1928.

Distinctive Features of Drainage in New England

The irregularity of the surface traversed and drained by the Connecticut River and its neighbors can be fully appreciated only by those who know New England. While most river systems look like the trunk, branches, and stems of a maple tree or elm, the drainage pattern in New England, and especially in New Hampshire, is more like that of an old apple tree in a deserted orchard—a gnarled trunk, twisted limbs, many withered branches, and here and there a sturdy offshoot or graft that entirely destroys the balance of the design. Headwater basins are diverse in size, shape, and space relationship. Gradients are variable and unrelated—a confusion of rapids and still waters, falls and lakes, bogs, ponds, and wide intervales. Floods gathering in such a country are subject to innumerable and unlike delays from start to finish. What happens on one tributary may be quite different from what happens on the next; and even the main river is likely to respond to a single storm with a flood that is not just a single rise and fall, but a series of waves of differing strength. The progress of any given flood crest down a branch or trunk is of course quite uneven in rate.

The effects of irregularity of slope are supported and magnified by the patchy, heterogeneous character of the mantle of glacial drift. Valleys are generally occupied by thick deposits of silt and sand spread in lakes during the recession of the ice sheet. Early in their history these lakes were drained, as the river systems were revived by uplift. For thousands of years they have been excavating terraces in the old valley filling and are now caught at many points on ledges, upstream from which they swing in oxbows on wide plains or intervales. The upper Coos[4] country between West Stewartstown and Lancaster, and the lower Coos between Woodsville and Bradford are the most extensive natural basins on the Connecticut north of the Massachusetts line. Their broad floors not only afford pondage but, if dry before the flood, soak up a noteworthy amount of water, which is slow to move away. The upland slopes and headwater valleys are occupied by a relatively waterproof blanket of boulder clay, in which a silt matrix, hard packed and full of stones, yields stubbornly to scour by streams. Water runs off quickly and rather abundantly without greatly changing the features. Here and there, where the till has unusual thickness in main or branch valleys, deep gorges have been sawed down since the Ice Age, as at the Fifteen Mile Falls below Lancaster, where a boulder-paved channel occupies the whole bed of the valley.

Before we can understand floods in such circumstances, therefore, or get far in planning flood warnings or other measures of safety against them we must gather facts in large number, so as fairly to represent the entire drainage basin, and analyze them more critically than would be necessary in the well arranged though at times equally violent river systems of the Middle West and South.

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[4] "Coös," or "Cohos," is Indian for flood plain, intervale.

Variable Factors That Combine in Floods

Among the factors that make up the flood equation of a New England river system we may count first of all that typical irregularity of terrain just discussed. Other variables of greater or less consequence are: rainfall, which differs in time of occurrence, duration, and intensity on different parts of the system; snow cover and river ice, which give special emphasis to spring freshets; vegetation cover, which includes diverse types of forest, pasture growth, and cultivated crops and which changes from season to season in capacity for absorbing or delaying run-off; and artificial structures, such as dams, bridges, and buildings touching the stream channel, which influence the flow of water at certain points and may give way under the strain of the flood and impart to it a fresh impulse. Each of these will be briefly reviewed.

RAINFALL

A single storm of wide extent, lasting from 24 to 48 hours and shedding from 4 to 8 inches of rain—or even less than that amount in case the ground is well saturated or well covered with snow—will create a strong flood, or freshet,[5] on the New England streams. Rains of that degree of intensity, spreading over most or all of the area of the drainage basin, occur only when cyclonic low pressure disturbances move over New England, commonly in a direction from south to north or from southwest to northeast. Southward-flowing rivers like the Connecticut get the rain sooner at their lower and middle courses than at their longer and more extreme headwaters. The slender form of the Connecticut drainage basin, its northeast-southwest trend, and the movement of storms up its length rather than down are favorable factors preventing the piling up of the flood.

Knowledge of rainfall in New Hampshire and Vermont is meager and inexact. Concord, Northfield, and Burlington alone are the regular U. S. Weather Bureau stations of New Hampshire and Vermont. Roughly thirty semi-official "coöperative observers" in these two states, and perhaps an additional dozen rain gauges kept by private individuals or power companies, not all reporting their results to the Weather Bureau and so not listed in the Climatological Summaries, bring the total number of rainfall stations in the "twin states" up to possibly 50. Among these, not a single one is on the top or side slope of a mountain. A few, indeed, are situated within five miles of a mountain, for example Glencliff, N. H., and Somerset, Vt.; but most of them represent average conditions of upland and valley and give little idea as to how heavy the rainfall may be, and how irregular, on the mountains. Data are too few to serve satisfactorily for the drawing of isohyetal lines. Discordances of rainfall among them are great and rather unsystematic. Casual measurements and impressions as to rainfall on the upper slopes of the White Mountains support the view that it is much heavier there and more frequent than at lower levels. Probably also it is highly irregular in amount and differs in successive storms, owing to the abrupt boundaries and the local and diverse form of these mountain groups and to the differing influence they have on winds coming from different quarters. Records kept at the summit house on Mt. Washington over a period of seventeen years, from 1871 to 1887, indicate an average annual precipitation there of about 82 inches, which is double that of the surrounding country.

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[5] The word "freshet," familiarly applied to a spring flood, in which snow contributes to the volume and floating cakes of ice create ice jams and add violence to the flood, appears to have proper use also as applied to autumn floods. It is so used by Belknap, careful historian of New Hampshire in the colonial period, who devotes a page or two of his preface of Volume 3 of the classic "History of New Hampshire" to the discussion of this word as understood in New England.

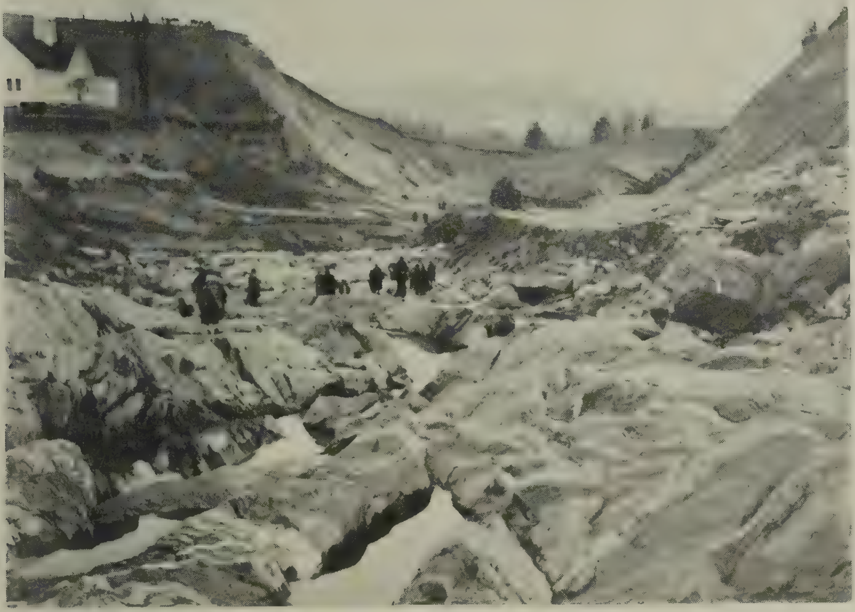

FIG. 1—Deep gorge cut through sand to rock along a new path by overflow of Black River, Cavendish, Vt. (Photograph by Frank H. Foster.)

In order to find out the facts about mountain rainfall in New Hampshire, arrangements have been made by the State Highway and Forestry Departments to get daily measurements during the present summer at 50 new stations on and near mountains. This study may show whether floods like that of 1927 are brought about in any considerable degree by excessive rainfall on mountain headwaters. All organizations and agencies that maintain a house, hut, fire lookout, or other station on a mountain in New Hampshire are coöperating in this study.

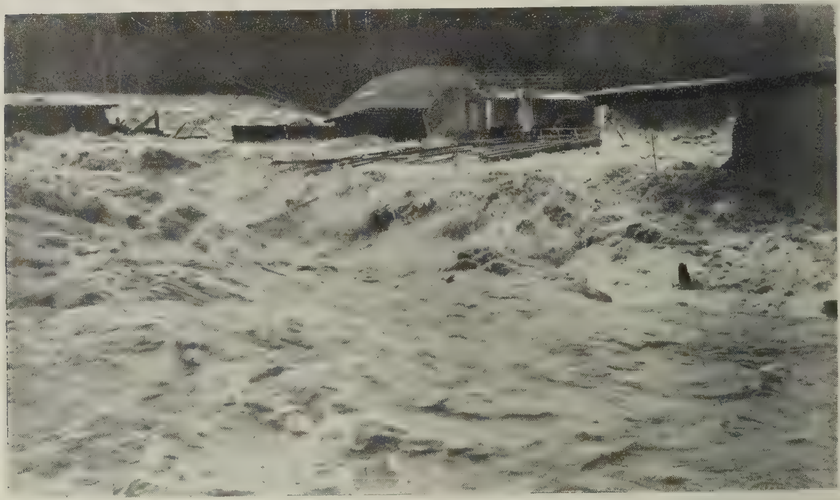

FIG. 2—The Passumpsic flood at record height. (Photograph by Theodore W. Chase.)

SNOW COVER AND RIVER ICE

The annual spring freshet of the New England rivers is commonly recognized as the combined product of warm rains and melting snow. River ice "going out" so fast as to jam at gorges and against bridges often aggravates the flood, both by concentrating and raising the wave and by supplying missiles that batter down structures in its path. Storage of winter precipitation in the form of snow is always large in the central Connecticut Valley district and the "north country" and often melts fast when the first warm wave of spring arrives in March or April. The actual thickness and density of this snow cover, however, varies greatly from year to year. Its area is even more variable. The weekly Snow and Ice Bulletins of the Weather Bureau strikingly illustrate this fact. Northern New England is so situated on and near the tracks of storms, which sometimes go north and sometimes south of it, and the 32-degree isotherm fluctuates so far and so often up and down its irregular surface that the ratio of snow to rain in the winter and spring seasons is quite indeterminate. Measurements of snowfall at Hanover since 1834, when plotted in a graph, appear wholly without system.

With a snow mantle whose area, density, and thickness on a given date in spring are sure to differ from those of previous seasons, the arrival of a warm wave whose intensity, area, and duration are also variables creates each year a freshet that always in detail and usually in larger characteristics is different from its predecessors (Fig. 4).

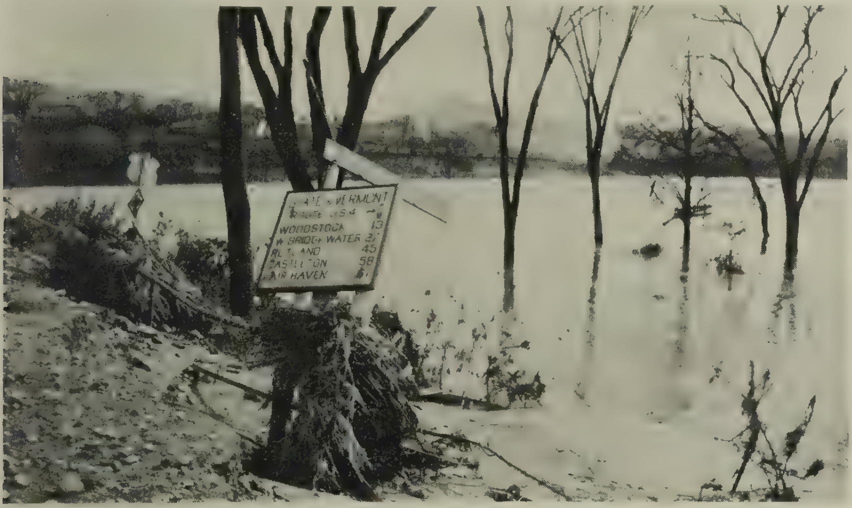

Fig. 3—After the flood at White River Junction.

Twice, at least, spring freshets of more than ordinary strength have been caused by excessive sunshine on lingering snow, without any rain at all. In 1862 one of the highest and worst floods on record in the Connecticut Valley came on April 18–19. The following notes, from contemporary newspapers, are of interest.

The recent flood on the Connecticut River was "one of the most formidable ever known, both as regards the extreme height of the water and the singular circumstances attending it." The river rose fast Saturday and Saturday night and reached at Sunday [the 19th] a "height little exceeded by that of 1854." A toll bridge at South Newbury, Vt., was swept away, and railway trains were stopped at Bradford. There were washouts on the railway along the Passumpsic. Some places on the Connecticut River had high water more than 22 feet above low-water mark (*Vermont Journal*, Windsor, Saturday, Apr. 26, 1862).

"An immense body of snow and ice existed in the northern part of this state [Massachusetts] and through Vermont and New Hampshire, and in many places sleighing over the tops of the fences was the style of traveling most in vogue." At Holyoke, the river stood 12 feet, 4 inches high on the dam, or 9 inches above the record of 1854 [the highest of that century]. At Hartford, Conn., the river had risen 28 feet above low water and was still rising, at 10 a. m. on Sunday, at the rate of an inch an hour. "A bridge on the Northern road at Lebanon [N. H.] is carried entirely away." Rivers all over New England were affected (*Springfield Republican*, quoted, *ibid.*).

A recurrence of this unusual type of flood came in April, 1928. This year, with almost no rain at all and with a cover of snow that was limited to the White Mountains and the upper Coos districts, a warm wave fully as intense as that of 1862 swelled the upper Connecticut, the lower Ammonoosuc, and the Passumpsic to heights never before reached. At Northumberland, partly because of ice jams, the water stood several feet higher than it had during the great flood of last November. Whitefield, Littleton, and other points on branches that head on the highest White Mountains got a record flood; and even the Passumpsic, with its relatively low upland basin, did more damage than usual in the spring break-up.[6] A large concrete dam at Gilman, below Lancaster, collapsed under the pounding of ice cakes, although it had stood the strain of the November flood five months before.

COVER OF VEGETATION

The distribution of forest, brushy land, open pasture, hayfields, and other types of cover is quite as irregular as the factors already discussed. Here and there in the mountains single summits or groups of summits rise above tree line. A violent and sustained rain on these unclothed mountain sides starts its downhill race with little or no delay. Steep gradient and lack of cover allow the excessively heavy rainfall of the summits to overtake the more slowly collecting run-off of the wooded slopes below. Thus the mountain rainfall has a flood-producing value greater than its actual volume might suggest. The White Mountain area is occupied by forests in all stages of cutting and recovery; but there is mostly mixed growth and brushy woodland. While much of it is scarcely merchantable timber, the foliage and ground carpet probably serve fairly well to delay run-off. The wholesale stripping of the forest on the mountains in the period from 1870 to 1900 has undoubtedly served to increase the tendency of the Connecticut and other rivers to flood,[7] yet it appears that this is largely counteracted by the gain in woodland area on abandoned farms throughout the central and southern parts of the state.

The chief point to be stressed here is, that the cover over the Connecticut drainage basin is very diversified and must be reckoned among the factors that cause different tributaries of the river to deliver floods of different sizes and at different speeds. More concrete and exact study of this factor in New Hampshire is contemplated.

ARTIFICIAL STRUCTURES

Ordinary freshets on the Connecticut and its branches seldom break dams or sweep out bridges; for wherever that has taken place the new structure has been more advantageously placed or more strongly built. Not a few of the old covered bridges of New Hampshire and Vermont built between 1830 and 1860 have been set back on their abutments to greater height than the original one, after a flood—especially in 1862, 1866, and 1869; and wherever new bridges have been built they have been placed higher than any known flood mark at that point. In spite of this, scores of bridges were swept away in November, 1927, giving one of the best indications that this flood broke all records for high water, at practically all points, since the middle of the last century. Several hundred bridges went out in the 1927 flood, in Vermont alone, of which perhaps 200 were on the Connecticut system. The headwaters of the White and Ottaquechee rivers suffered most from collapse of dams and washouts of structures bordering the channel. Storage behind a dam first retarded the progress of the flood; then, as pressure became too strong or a washout around one side of it started undermining the structure, the ponded water was suddenly released, forming at that point a flood wave with an unnaturally sharp crest and steep front, which raced downstream threatening to break other dams, one by one, where storage of water from other tributaries was being held in check. Thus an augmented flood wave may have developed, of greater intensity than nature alone would have created. Smaller contributions to height and strength of flood came where mills or bridge foundations gave resistance to the swollen current but finally went out, particularly where bridges banked high with wreckage suddenly gave way, like an ice jam in an early spring freshet.

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[6] For a brief account of this see J. W. Goldthwait: The Spring Freshet of 1928, *New Hampshire Highways*, Vol. 6, No. 2, May, 1928.

[7] M. O. Leighton: Floods, in "Papers on the Conservation of Water Resources," *U. S. Geol. Survey Water Supply Paper 234*, 1909, pp. 10–27; particularly pp. 20–22.

Just how much of the violence of the November flood on Vermont tributaries was due to weakened dams and other structures along the river system and just how far downstream from a given point the effect of a break or washout reached cannot be stated; but reports of the time of peak flood include both statements and opinions regarding delay or acceleration of the flood from this cause. Obviously, this is a factor that played a greater rôle on the small streams than on the larger ones; for few of the modern power dams on the main lines of drainage went out, while many old milldams in the headwater districts collapsed. This accounts for some of the discrepancies in time of high water shown in the western part of the map (Pl. V).

Ordinary and Extraordinary Floods

High water in the Connecticut system comes definitely twice each year, in spring and fall, in response to the spring and fall rains. When summer precipitation is heavy, it is too local in character and too much delayed by the vegetation cover to build up a vigorous flood on the main river. Midwinter storms likewise rarely produce floods.

Table I—Historic Floods on the Connecticut River

Year	Season	Comment
1771	Fall	Possibly given prominence because it was the first one to cause suffering and damage to settlers in the lower Coos, near Bradford, Vt. (Grant Powers: Historical Sketches of the Discovery, Settlement, and Progress of Events in the Coos Country and Vicinity, Principally Included Between the Years 1754 and 1785, Haverhill, N. H., 1841, pp. 112–114.)
1775	Oct. 20–22	At Charlestown, N. H., higher than for 30 years at this season. Followed three days of rain. (Journal, manuscript, of Enos Stevens at Charlestown. Original in possession of Mr. Henry N. Stevens of London, Eng. Copy now in Town Clerk's office at Newbury, Vt.) Flood not so bad on Wells River at Boltonville; for grist mill there was completed and set running on Oct. 28, 1775, indicating that the mill dam could not have been carried away. (Journal of General Whitelaw, quoted in History of Newbury, Vt., by F. P. Wells, p. 66.)
1785	October	A great freshet throughout New England, with 9 inches of rainfall reported in some places.
1801	Mar. 17–21	The "Jefferson flood." Highest since 1692 at Hartford, Conn., where it registered 27.5 feet. Higher than for 20 years at Keene, N. H.
1824	Feb. 10–13	Highest for 60 years at Bellows Falls, where it stood between 25 and 30 feet above low water. All bridges over the Black River reported gone. Green at Woodstock, Vt., completely inundated. Bad ice jams.
1826	Aug. 28–29	Torrential rain in White Mountains. Landslides at Willey Brook and many other points. Ammonoosuc River at Bretton Woods reported to be 16 feet above normal.
1828	Sept. 3–5	(Cf. record of 1862 flood.) Water at Windsor, Vt., reported 20 feet above normal.
1841	Jan. 8	Highest since 1801 at Hartford, Conn. (26.3 feet). Much damage to bridges at Lebanon, N. H., Hanover, Fairlee, Bradford, Wells River, and along the lower Ammonoosuc. Caused by rains on heavy snow cover.
1854	May 4–7	The "Nebraska flood." Said to be "not paralleled for at least 50 years." Fully as high as the flood of 1801, at Springfield, Mass.
	Apr. 18–19	The "Secession flood." Caused wholly by quick thaw of dense, thick snow cover over all Vermont, New Hampshire, and northern Massachusetts. At Holyoke, Mass. reached point 9 inches higher than flood of 1854 (12.5 feet on gage). Never since equaled. At Bellows Falls, 22 feet above low water. Swept away toll bridge at South Newbury, Vt.

YEAR	SEASON	COMMENT
1866	Mar. 3–4	Strong spring freshet of usual rain-thaw-ice-jam type, particularly destructive near Windsor, where the Cornish toll bridge went out.
	Apr. 25	Another bad flood, destroying many dams and bridges on the Passumpsic.
1869	Oct. 2–5	The best-remembered flood of this generation, prior to 1927. Locally higher and more destructive than that, but in the great majority of places inferior to it. 7-to-8-inch rainfall at Concord, N. H., 6.07 inches at Hanover. About a foot lower than the flood of 1862 at Bellows Falls and Vernon. Well recorded at many places by spikes in trees and other markers.
1878	Dec. 11	Heavy flood at Brattleboro. Highest since 1854 at Hartford, Conn.
1895	Apr. 15–17	9 feet lower than the flood of 1927 at Brattleboro; 7 feet lower than that flood at Bellows Falls; but definitely one of the high floods.
1896	Mar. 1–3	Somewhat lower than that of 1895 yet, like it, properly included among the high floods. This and the preceding one were much more severe on the Merrimac River.
1913	Mar. 28	Approximately the same height as that of 1895 at Bellows Falls and Brattleboro. Reported 30 feet on the gage at White River Junction.
1922	Apr. 12–14	High water 26.8 feet at White River Junction. Took out a bridge at Woodsville, N. H.
1927	Nov. 3–5	Highest records everywhere on the system, except locally on small branches and in the extreme north country. 8 inches above the mark of 1869 on Newbury, Vt., meadows. 5.7 feet above the record of 1869 at Bellows Falls.

February, particularly, is free from floods, probably because of the generally low temperatures and blanket of snow and the improbability of a sustained thaw and warm rain lasting over a period of days. The two maxima of flood occurrence come in early April and middle October (Fig. 4). Because the spring floods are fed largely by snow accumulated during the preceding winter, they are commonly much higher and stronger than the fall floods. Because of variability in snow cover, temperatures, and rainfall also they are more diverse and complex than those of fall (Fig. 4). Extreme floods have occurred, nevertheless, at both seasons. The great fall floods of 1775, 1785, 1828, 1869, and 1927 were as high as the spring floods of 1801, 1824, 1896, and 1913. This means, perhaps, that the fall rainstorms are heavier—tropical cyclones that have come along an inland path, with more moisture and higher temperatures than the "lows" from

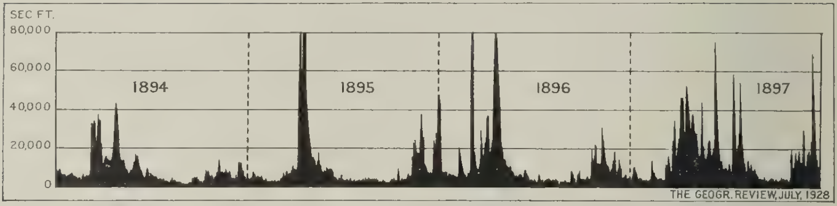

FIG. 4—Discharge of the Connecticut River at Holyoke, Mass., for the years 1894–1897. Characteristics shown are: a spring and a fall flood every year; flood discharge from 10 to 20 times low-water flow; diversity in floods, especially those of spring, as illustrated by the several small freshets of March and April, 1894, the single big freshet of April, 1895, the strong freshets of March and May, 1896, and the prolonged fluctuations of high water from March to July, 1897. (From *U. S. Geol. Survey, 20th Ann. Rept.*, 1899, Vol. 4, Fig. 11 on p. 77.)

the interior—or that the run-off is more rapid on bare ground than on a snow cover.

In the accompanying list (Table I) are all the freshets on the Connecticut River since 1771 that are known to have greatly exceeded the ordinary high waters of spring and fall. Single branches or groups may have had local floods at other dates. Figure 5 shows the distribution of these floods by months. Although the number of cases is not large, the two maxima on this curve signify the same seasonal distribution as that shown in Figure 4. A similar curve has been found for 37 floods that affected New England as a whole.[8]

THE FLOOD OF NOVEMBER 3–5, 1927

The flood of last November is not only the greatest fall flood on record in New England but is the equal probably of any other flood at any time of year in New Hampshire and Vermont. The flood of 1692 can hardly be compared with it, because knowledge of that flood is limited to the lower stretches of the river below Hartford, Conn. Like other fall floods, this one is a direct response to a rainstorm of unusual intensity and duration, drenching ground that was already soggy in headwater districts and passing into the stream channels so promptly and rapidly as to overflow them at their very extremities. Pools and temporary ponds developed in unfamiliar places. Wide sheets of water overspread high-level intervales like those at Crawford's and Bretton Woods under Mt. Washington. Thence these hundreds of little tributary floods raced down their converging courses, expanding on flood plains, crowding through bottle-neck gorges, piling up on dams, and combining, two by two, until they reached the main stem in the form of well organized waves, steeper in front than in back. The particular manner in which these diverse tributary floods of the Connecticut system gathered, moved forward, and combined will now be reviewed.

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[8] Lougee, *op. cit.*, figure on p. 14.

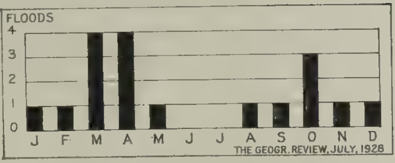

FIG. 5—The occurrence, by months, of extreme floods on the Connecticut River since 1771. Compare Table I.

During the two or three weeks before this flood all foliage had fallen from the trees; so the rain lost no time in reaching the ground. If the leaf carpet acted as a detaining agency, this soon ceased; for the soil and subsoil were already soaked. No measurable amount of snow had fallen anywhere in the drainage area unless on the mountains; and there was no ice in the streams.

THE RAINSTORM IN NEW ENGLAND

Moving up the coast of the Carolinas, a tropical "low" left its ocean track, because of high pressure athwart it, in New England and the Maritime Provinces, and came inland, over Long Island and Connecticut, heading straight for the Connecticut Valley.[9] As the warm moist air in this "low" was driven against the upland ridges of the Berkshires and the Green Mountain Range and rode higher and higher over stagnant masses of cold air left by the "high" in the lee of these ridges, rain formed rapidly and fell in torrents, first over Connecticut, then western Massachusetts, and then Vermont and New Hampshire. Within 36 hours a month's rainfall had descended on Vermont and parts of the adjoining states. Although isohyetal maps of this rainstorm have been made they give an inadequate picture of it; for the measurements are limited to stations in valleys and on hills of moderate altitude. There were no observations on mountains, and the intensity of the mountain rainfall can only be guessed from reports like the following.

> The rain at Randolph [N. H.] was all Nov. 3rd and 4th. I do not think there was any on Nov. 5th. The rain began in the morning of Thursday, Nov. 3rd, and continued all day except about one hour in the afternoon. The air was warm (perhaps 60° F.), and the wind was south and blew rather hard at times—unusual for south winds at Randolph. The intensity of rainfall was not extraordinary, and the Moose did not rise more than is usual in all-day rains. In the night the rain and wind increased, and when it was light enough Friday morning we saw that the Moose was higher than we had ever known it before. The rain continued, rather hard, till about noon, and then was intermittent for the rest of the day. The air was warm all day. The wind was southeast, east, northeast, and for a short time in the afternoon blew from the north. Before dark the lower clouds broke away so that we could see almost to the summit of Adams. Nine large cascades could be seen pouring down the walls of King's Ravine. Usually, after a storm we cannot see any cascades in King's Ravine from our house.
>
> I am strongly inclined to believe (though I have no positive proof) that the total precipitation on the heights of the Mt. Washington Range was considerably

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[9] Compare H. C. Frankenfield: November Floods in New England and Eastern New York, *Mon. Weather Rev.*, Vol. 55, 1927, pp. 496–499. See also H. K. Barrows: Flood Rainfall in New England, *Engineering News-Record*, Vol. 99, 1927, pp. 796–798.

greater than in the valley at Randolph. What we saw when the clouds broke as above described, the fact that it was still raining on the slope of Adams during some of the intermissions in the rain Friday afternoon, the fact that it often rains more on the northern slope of the Range than in the valley and that the summit of Washington is the rainiest place at which records have ever been kept in New England, the unprecedented flood in the Peabody, the great flood in the Ellis, both seeming to point to a very extraordinary rainfall on their respective drainage areas, the great slides brought down from Mt. Washington, Mt. Jefferson and Israel Ridge, and the fact that the rain came from a warm, moist southeast wind, which, it would seem, would deposit most water where most cooled in rising to slide over the heights, are the reasons which lead me to this belief. . . .

. . . . An open box was left here the day before the storm, and the day after the storm 7 inches of water was found in it. While this is not a standard measurement of rainfall, it seems likely to be approximately correct, or else too small, as we do not know how much water leaked from the box before it was measured. (Letter from Louis F. Cutter, Civil Engineer, Salem, Mass., and Randolph, N. H.)

At Bemis Station, or "Notchland," in Crawford Notch, Mrs. Florence Morey reports that a pail that was empty before the rain Thursday was full to overflowing Friday morning, indicating at least 8 inches rainfall in that short time. At Lost River Cabins, in Kinsman Notch, an empty barrel, according to observations of Mr. Michael E. McCarthy, gathered 14 inches of water during the storm. This is the largest amount reported anywhere, so far as I know. It may be that these large figures are no greater, in proportion, than the usual excess at the places mentioned, which are all situated where mountain ranges may act as funnels against driving storms. They serve at least to emphasize the part played by mountain rainfall in swelling the headwaters and suggest that a region as rugged and irregular as the White Mountains gets far more heavy precipitation than is usually shown on isohyetal maps.

The rain was far ahead of the center of the storm, as it came northward. The heaviest rain in southwestern and central Vermont came on the afternoon and evening of November 3, when the storm center was off New Jersey, well south of Long Island[10] and reached the Passumpsic Valley and the north country early Friday morning, when the center was over southern Connecticut. Exact measurements of irregularity in precipitation from hour to hour are few and scattered. The record at Northfield (Fig. 6) is the best. There, as elsewhere at headwater points, the crest of the flood came very soon after the rain began to let up. Reports from Randolph, N. H., and several places in southeastern Vermont agree on this. Certain flashy streams rose and fell twice, in response to two maxima in intensity of rainfall. Probably some discrepancies in reports are due to double rainfall maxima with observations only of the earlier peak.

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[10] J. H. Weber and C. F. Brooks: The Weather-Map Story of the Flooding Rainstorm of New England and Adjoining Regions, Nov. 3 and 4, 1927, *Journ. New England Water Works Assn.*, Vol. 42, 1928, pp. 91–103.

THE FLOOD FROM THE WHITE RIVER

Owing partly to the movement of the rainstorm over the long drainage basin and still more to the differences in shape, size, and gradient of the main branches of the Connecticut, the gathering of floods into the trunk river was highly irregular. All of the Vermont branches as far north as the White River had collected their floods and were having the peak stage far down their courses by midnight, on Thursday–Friday, Nov. 3–4. The series of floods from these Vermont basins poured in in the order of their position on the map. The prompt discharge of floods from the Vermont side is a striking contrast to the slow and odd behavior of the New Hampshire tributaries—the Ashuelot, Cold, and Sugar rivers. These drain areas of gentler gradient, where detention basins are larger and more numerous and irregularity is great. The New Hampshire floods came slowly, reaching the Connecticut from four to twelve hours after those from Vermont.

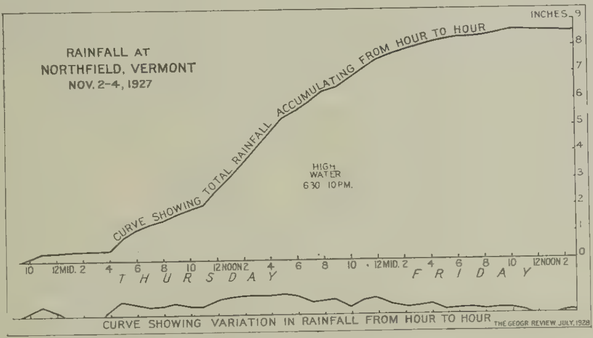

FIG. 6—Rainfall at Northfield, Vt., Nov. 2–4, 1927. The upper curve shows the total rainfall accumulating from hour to hour; the lower curve the variation in rainfall from hour to hour. (From the report of W. A. Shaw, U. S. Weather Bureau observer.)

While the rain on southeastern Vermont was quickly passing down the system into Massachusetts and while the tributary floods from the New Hampshire side were maneuvering independently, two Vermont tributaries of outstanding importance, the Ottaquechee and White rivers, collected and delivered a deluge which operated along the whole length of the Connecticut Valley below White River Junction as one great unit. These two tributaries more fully than the others gather drainage by convergence of several secondary branches in roughly circular basins, which means that several floods coming down the secondaries arrive almost synchronously and pile up in a sharply defined flood instead of being prolonged and flattened. As the White River has the largest single basin that discharges into the Connecticut system and as its flood built up on top of the floods from the Ottaquechee and more southerly branches, this wave that made the high-water record from White River Junction down to Vernon may properly be called the White River flood. In the damage which they caused, the Vermont branches quite overshadowed those of southwestern New Hampshire; not so much, it seems, because of greater rainfall as because of better organized run-off along their converging secondaries and their relatively steady gradients and narrow valleys. They are comparatively free from both natural and artificial storage basins.

The best contrast in tributary floods is between the White River and the Mascoma, which come into the Connecticut from opposite sides at White River Junction. The Mascoma is a complex little system in itself, with ponds at many of its sources and marshy intervales at others, as well as one good-sized lake halfway down its main stem. All these are subject to control by dams. So, although this river drains the side slopes of Mt. Cardigain, Smart's Mountain, and Moose Mountain, the flat gradients and easily flooded intervales just downstream from them, together with the ponds, greatly delayed the arrival of floods from the upper half of the basin and threw them out of synchronism.

THE FLOOD FROM THE PASSUMPSIC-AMMONOOSUC SEGMENT

Above White River, the flood on the Connecticut was derived chiefly from the basins of the Passumpsic and Lower Ammonoosuc, with small accessions from the Wells, Ompompanoosuc, and other rivers. Most of the first-order tributaries in this district are short. The drainage basin of the Connecticut for nearly forty miles is narrow, with the watershed at one place, on the east side of it, only six miles away. The Connecticut, for fifteen miles or more, in this "lower Coos" district, winds in great oxbows on a flood plain more than a mile wide. Here the floods from the Wells, Lower Ammonoosuc, and Passumpsic rivers collected, arriving at Woodsville about six hours apart, at 8 a. m., 3 p. m., and 8 p. m. Rainfall over the Passumpsic basin was no heavier than elsewhere in this part of New Hampshire and Vermont; but the concentration of run-off created a greater flood here, as it has done many times before. It took the Passumpsic flood about five hours to make its way down the Connecticut Valley from East Barnet to Woodsville and to build up behind the floods already gathered there from the Wells and Lower Ammonoosuc rivers to a maximum stage. Thence, like the White River flood, this Passumpsic wave flowed down the valley leaving high-water marks never before equaled and not approached when the flood from the upper Connecticut or north country came through almost two days later. At Newbury, on the lower Coos, the water overspread the intervales, rising slowly until it stood eight inches higher than the well-recorded mark of 1869 and making a lake ten to twenty feet deep and from one to two miles wide. The pondage here is enormous and accounts largely for the construction of a single symmetrical flood wave out of the three contributing basins above

Woodsville. It advanced at the rate of about two miles an hour and arrived at White River Junction 34 hours after the White River flood had left.

THE FLOOD FROM THE UPPER COOS OR NORTH COUNTRY

The third flood which gathered in the upper reaches of the Connecticut system was later, flatter, and slower than either of the others. The map (Pl. V) shows in outline how freakish and how different in size these northern branches are. It cannot, however, express adequately the oddity and diversity of the country around these streams. Some drain rugged mountain slopes, some lie almost wholly in low ground, with ponds, lakes, and swamps interrupting the flow. More of this country is forested than farther south.

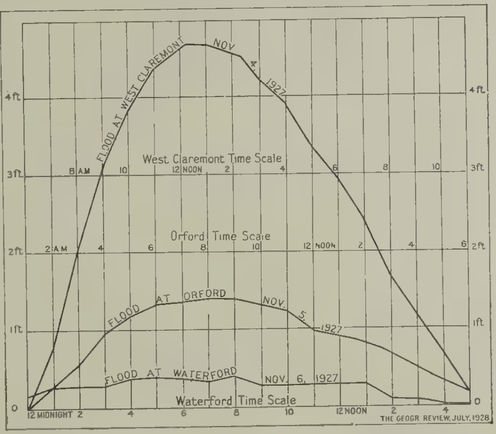

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FIG. 7—Rise and fall of the November, 1927, flood on the Connecticut River as measured hour by hour at three points: (1) flood from the White River, measured by Roy D. Hunter at West Claremont, peak noon of Nov. 4; (2) flood from Ammonoosuc-Passumpsic, or Lower Coos, region, measured by W. R. Harris at Orford, peak morning of Nov. 5; (3) flood from north country, or Upper Coos, region, measured by New England Power Construction Co. at Waterford bridge, peak morning of Nov. 6.

The vertical scale is the same for the three cases; but the crests of the floods are plotted one above the other for ease of comparison. Only the peak portion of the Waterford curve is shown. This long flat wave took five days to rise four and a half feet to its peak and fall again, while the flood from White River rose and fell that amount in less than 18 hours.

Floods from tributary basins in this north country are almost sure to fail to synchronize, yet pondage on the intervales from West Stewartstown south to Lancaster and Gilman dam tends to unite these floods before they move down the long gorge of the Fifteen Mile Falls to the Passumpsic. The New England Power Company's measurements at Waterford bridge, halfway down the Fifteen Mile Falls, show a surprisingly prolonged rise of water for 36 hours, which reached its flat peak from four to eight o'clock Sunday morning. The fall of the flood was equally slow and steady. So, we find the third flood wave originating in the north country, becoming simplified and elongated in the meadows of the Upper Coos, gathering speed on its way down the gorge of Fifteen Mile Falls, but arriving at East Barnet 42 hours after the Passumpsic flood had left that point.

Like three divisions of a great street procession, these three floods moved down the Connecticut Valley, in series and well spaced: the biggest and fastest coming out of the White River valley at four o'clock Friday morning, the Passumpsic-Ammonoosuc flood coming along 34 hours later, and the flood from the north country, longest, flattest, and slowest, starting 42 hours behind the second one.

THE NEED FOR STUDY OF FUTURE FLOODS

The threefold division of this great flood of November, 1927, on the Connecticut River is probably a typical feature, likely to be seen almost every time a major flood comes down through the system; for the drainage basin itself has three distinct parts. Variants from this type are sure to come, however.

Minor floods on the main river will often originate in a flood of considerable strength gathered by one of its branches or in one of its three main segments. The really high spring freshet of this year (1928) is a case in point. While the 1928 freshet is exceptional in having developed wholly from thawing of the snow cover in the north country and the White Mountains, it emphasizes the fact that those districts above all others in the drainage basin are likely to have a thick cover of snow and to flood in spring when the first sustained warm wave—accompanied almost always by rain—arrives. Those dwelling along the middle and lower course of the river are accustomed to find it rising to unexpected height at this season in April or early May when no flood-producing rains or thawing snow in the central area had been noticed. Heavy local rains are likely to create floods of all sizes within subdivisions of the system. Summer thunderstorms, sometimes coming a few hours apart over nearly the same path, are their commonest cause. Their effects are almost equally local.

Those floods that have risen highest and done most damage along the main river seem each time to have been gathered from the whole drainage area, when a single great rainstorm advancing northeastward or northward completely overspread it. It is not likely that the direction of movement of such a storm will ever be different from this, which, as remarked, is a most favorable condition for the Connecticut. Rivers of much greater area, like the Mississippi, attain full flood only when visited by successive rainstorms, so placed and timed that the flood that comes down one branch, in response to an earlier storm or series of storms, meets a flood coming down a lower tributary in response to a later one. Such a combination would seem unlikely on a river whose drainage area is as small as the Connecticut; for cyclonic storms, or "lows," are hundreds of miles in area and move at such slow rates across the country that it is unusual for two of them to pass nearly over a limited district within two days of each other. That there is a chance of a combination of this sort, however, is a matter of real concern in preventing damage from future floods.

PLACES REPORTING TIME OF FLOOD CREST

	STATION		Nov.
1	Pittsburg	M'dn't	4
2	Indian Stream	10.30 p.m.	4
3	Beecher Falls	M'dn't	4
4	W. Stewartstown	10 p.m.	4
5	Colebrook	9.30 a.m.	4
6	Kidderville	6 a.m.	4
7	Lyman Falls	8 p.m.	4
8	Wenlock	3 p.m.	4
9	Bloomfield	3 p.m.	4
10	N. Stratford	10.30 p.m.	4
11	Brunswick	5 a.m.	5
12	Maidstone	7 a.m.	5
13	W. Milan	2.30 p.m.	4
14	Crystal	8 p.m.	4
15	Percy	9.12 p.m.	4
16	Stark	8 p.m.	4
17	Nash Stream	3 p.m.	4
18	Groveton	2 a.m.	5
19	Guildhall	5.12 p.m.	5
20	E. Lancaster	9.30 a.m.	4
21	Riverton	noon	4
22	Lancaster	1 p.m.	4
23	Hazen's	12-4 p.m.	4
24	Whitefield	3-4 p.m.	4
25	S. Lunenburg	7.30 a.m.	6
26	Gilman	9.30 a.m.	6
27	Waterford	4-8 a.m.	6
28	Granby	7 a.m.	4
29	Victory	8 p.m.	4
30	N. Concord	9 p.m.	4
31	Concord	5 p.m.	4
32	E. St. Johnsbury	10.30-11 a.m.	4
33	East Haven	9 a.m.	4
34	E. Burke	10.30-11 a.m.	4
35	Newark	8-11 a.m.	4
36	Sutton	8-10 a.m.	4
37	W. Burke	6.30-7.30 a.m.	4
38	Sheffield	5 a.m.	4
39	Wheelock	6 a.m.	4
40	Lyndonville	10-10.30 a.m.	4
41	Lyndon	12-12.30 p.m.	4
42	N. Danville	11 a.m.	4(?)
43	St. Johnsbury	12-2 p.m.	4
44	Passumpsic	11 a.m.-3 p.m.	4
45	W. Danville	11 p.m.-1 a.m.	3-4
46	S. Danville	10-10.30 a.m.	4
47	E. Barnet	12-4 p.m.	4
48	Peacham	9 a.m.	4
49	S. Peacham	6-7 a.m.	4
50	W. Barnet	10.15 a.m.	4
51	Barnet	3 p.m.	4
52	E. Ryegate	6-7 p.m.	4
53	Ricker's Mills	1-5 a.m.	4
54	Groton	5 a.m.	4
55	S. Ryegate	M'dn't	3
56	Boltonville	7 a.m.	4
57	Wells River	8 a.m.	4
58	Fabyan's	8 a.m.	4
59	Twin Mt.	8 a.m.	4
60	Littleton	10 a.m.	4
61	Franconia	11 a.m.	4
62	Lisbon	10.30 a.m.	4
63	Bath	1 p.m.	4
64	Swiftwater	10 a.m.	4
65	Benton	2 a.m.	4
66	Woodsville		
	(Ammonoosuc R.)	2-3 p.m.	4
	(Conn. R.)	6-7 p.m.	4
67	Glencliff	7-8 a.m.	4
68	Bradford		
	(Conn. R.)	M'dn't-7 a.m.	4
69	Piermont	4-5 a.m.	5
70	E. Orange	11.30 p.m.	3
71	Topsham	M'dn't	3
72	E. Corinth	5 a.m.	4
73	W. Corinth	9-10 p.m.	3
74	Corinth	9-11 p.m.	3
75	Bradford		
	(Waits R.)	7 a.m.	4
76	Orford	8-9 a.m.	5
77	Orfordville	6 a.m.	4
78	Vershire	10-12 p.m.	3
79	W. Fairlee	12-6 a.m.	4
80	Post Mills	8-9 a.m.	4
81	Thetford Cen.	12-2 a.m.	4
82	Strafford	M'dn't	3
83	Union Village	10-12 p.m.	4
84	Hanover		
	(above big bend)	11 a.m.	5
	(Ledyard Bridge)	1 p.m.	5
85	Norwich	1 a.m.	4
86	Greensboro	7 a.m.	4
87	Chelsea	7-8 p.m.	3
88	Tunbridge	9-10 p.m.	3
89	Brookfield	9-9.30 p.m.	3
90	E. Randolph	11.30 a.m.	4
91	E. Granville	10-11 p.m.	3
92	Braintree	1-2 a.m.	4
93	Randolph	9 p.m.-9.30 a.m.	3-4
94	Granville	10.30 p.m.	3
95	Hancock	7-8 p.m.	3
96	Rochester	2 a.m.	4
97	Talcville	11.30 p.m.	3
98	Stockbridge	10.30 p.m.	3
99	Pittsfield	1 a.m.	4
100	Tweed River	2 a.m.	4
101	Gaysville	11 p.m.	3
102	Barnard	8-9 p.m.	3
103	Bethel	11.30 p.m.	3
104	S. Royalton		
	(west)	1 a.m.	4
	(village)	1.30 a.m.	4
	(east)	1 a.m.	4
105	Sharon	1.30 a.m.	4
106	N. Pomfret	M'dn't	3
107	W. Hartford	3 a.m.	4
108	White River Junc.	4 a.m.	4
109	Canaan	10.30 a.m.	4
110	W. Canaan	2 p.m.	4
111	Enfield	11 a.m.	5
112	Mascoma	6 a.m.	4
113	Stony Brook	10-12 p.m.	3
114	Lebanon (town)	5 p.m.	5
	(mouth Great Br.)	3 p.m.	4
	(below Great Br.)	3-4 p.m.	4
	(Electric Plant)	2 a.m.	4
115	Sherburne	10-12 p.m.	3
116	W. Bridgewater	2 a.m.	4
117	Bridgewater Cor.	11 p.m.	3
118	Bridgewater	11.30 p.m.	3
119	Woodstock	1-2 a.m.	4
120	S. Woodstock	12-2 a.m.	4
121	Quechee	3 a.m.	4
122	Dewey's Mills	3 a.m.	4
123	Evarts	2 a.m.	4(?)
124	Meriden	3 a.m.	4
125	N. Hartland	7.30-8 a.m.	4
126	Hartland 4 Cors.	2 a.m.	4
127	Windsor (north)	11.15 a.m.	4
	(toll bridge)	11.30 a.m.	4
	(Mill Brook)	5 a.m.	4
128	S. Reading	1 a.m.	4
129	Brownsville	1-4 a.m.	4
130	Grantham	M'dn't-noon	4-5
131	Guild	7.45 a.m.	4
132	Mill Village	4 a.m.	4
133	N. Newport	2 p.m.	4
134	W. Claremont (Coy Paper Co.)	11 a.m.-2 p.m.	4
135	W. Claremont		
	(Conn. R.)	1 p.m.	4
136	Plymouth Union	9-11.30 p.m.	3
137	Healdville	2.30-3 a.m.	4
138	Ludlow	3 a.m.	4
139	Proctorsville	2 a.m.	3
140	Cavendish	2 a.m.	3
141	Perkinsville	10 p.m.	3(?)
142	Springfield	7-8 a.m.	4
143	Gassetts	10.30 p.m.	3
144	Weston	12.30-1 a.m.	4
145	Simonsville	8 p.m.	3(?)
146	Chester	2 a.m.	4
147	Bartonsville	11 p.m.-3 a.m.	3-4
148	Grafton	2 a.m.	4
149	Saxton's River	2 a.m.	4
150	Bellows Falls		
	(above dam)	5.30 p.m.	4
	(below dam)	7 p.m.	4
	(mouth Saxton's R.)	4-5 a.m.	4
151	S. Acworth	7 a.m.	4
152	Drewsville	8.30 a.m.	4
153	Walpole	12.30 a.m.	5
154	Westminster	M'dn't	4
155	Putney	11 p.m.-1 a.m.	4-5
156	Londonderry	10 p.m.	3
157	S. Londonderry	10.30 p.m.	3
158	Peru	6-7.30 p.m.	3
159	Bondville	10 p.m.	3
160	Winhall Sta.	11 p.m.	3
161	Jamaica	11.30 p.m.	3
162	Wardsboro	11.30 p.m.	3
163	E. Jamaica	11.30 p.m.	3
164	Newfane	11-11.30 p.m.	3
165	Williamsville	10 p.m.	3
166	W. Dummerston	2 a.m.	4
167	Chesterfield	2 a.m.	5
168	Brattleboro	1 a.m.	5
169	Marlboro (Vt.)	7 a.m.	4
170	Vernon	1 a.m.	5
171	Marlow	1 p.m.	4
172	Gilsum	noon	4
173	Surry	9 a.m.	4
174	Munsonville	7 a.m.	4
175	E. Sullivan	10.30 a.m.	4
176	Marlboro (N. H.)	1 p.m.	4
177	Keene	9.30-10 p.m.	4
178	Troy	4 a.m.	4
179	W. Swanzey	8 a.m.	5
180	Westport	3-4 p.m.	5
181	Winchester	3-4 p.m.	5
182	Ashuelot	9-12 p.m.	5
183	Hinsdale	2-3 a.m.	6
184	Heartwellville	8-9 p.m.	3
185	Searsburg	7-8 p.m.	3
186	Readsboro	9.30 p.m.	3
187	W. Dover	8 p.m.	3
188	Wilmington	11 p.m.	3
189	Jacksonville	2-3 a.m.	4
190	W. Halifax	9-10 p.m.	3
191	GreenRiver	8.45 a.m.	4

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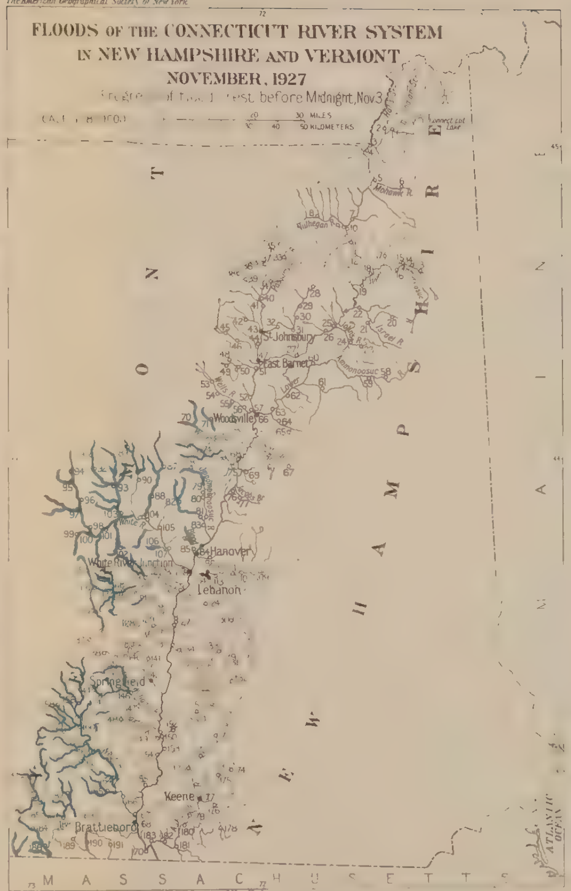
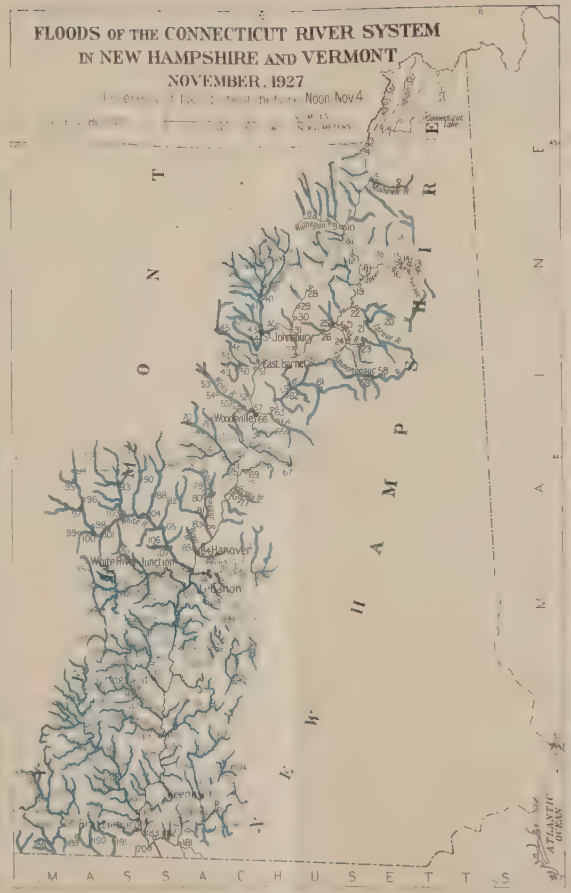
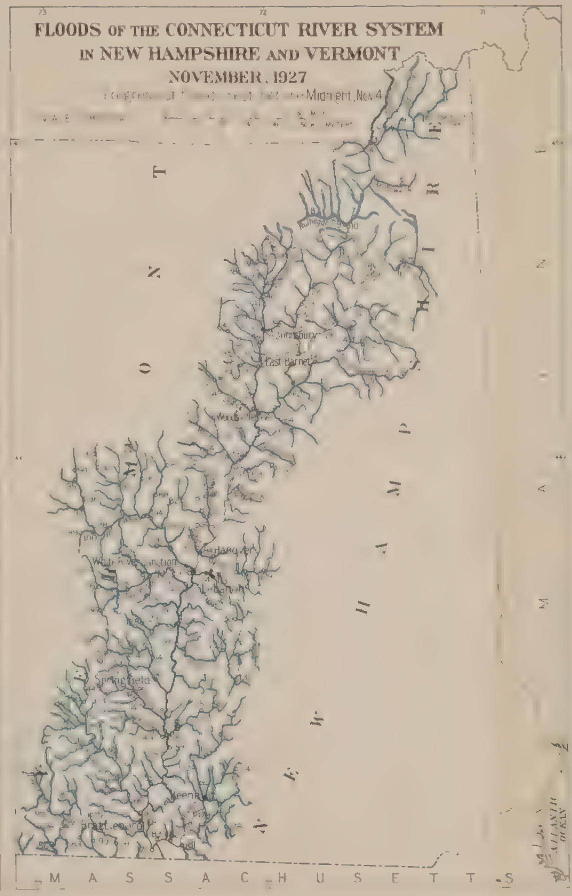
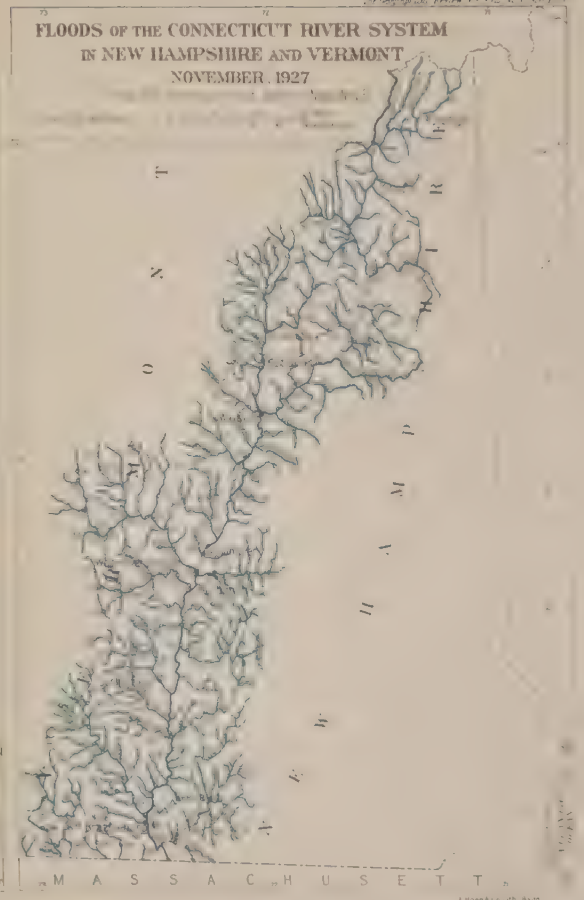

FLOODS OF THE CONNECTICUT RIVER SYSTEM IN NEW HAMPSHIRE AND VERMONT
NOVEMBER, 1927
Progress of flood crest before Midnight, Nov. 3


FLOODS OF THE CONNECTICUT RIVER SYSTEM IN NEW HAMPSHIRE AND VERMONT
NOVEMBER, 1927
Progress of flood crest before Noon Nov 4


FLOODS OF THE CONNECTICUT RIVER SYSTEM IN NEW HAMPSHIRE AND VERMONT
NOVEMBER, 1927
Progress of flood crest before Midnight, Nov. 4


FLOODS OF THE CONNECTICUT RIVER SYSTEM IN NEW HAMPSHIRE AND VERMONT
NOVEMBER, 1927

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We have seen that the flood that gathered in the upper Coos, or north country, was 42 hours too late, at East Barnet, to synchronize with the strong flood of the Passumpsic. Part of this delay may have been due to northward storm movement and consequent difference in time of origin of the two floods. But so far as that is so, the case is probably normal. We may fairly assume that the crest of a north country flood will take roughly two days to reach Woodsville. Suppose, now, that a north country flood is created, in spring, by the thawing of an exceptionally thick snow cover, with or without rain. It takes two days to get going. If, then, a second flood-producing rainstorm should arrive early on the third day in the southernmost or the middle portion of the drainage basin, it would be just in time to produce a flood on the White River or the Passumpsic or the Ammonoosuc that would synchronize with the flood from the north country and accomplish twice the concentration that came in November, 1927, at White River Junction or Woodsville or East Barnet.

Proper organization for protection against floods might include as a first step the establishment of 20 or 30 rainfall stations at points well distributed over the drainage basin, with some, certainly, on mountains. Any excessive 24-hour measurement could be promptly reported by telephone or telegraph or radio to a central office. Stream-gaging stations, both on headwaters and along the main rivers, would give knowledge of the height and rate of advance of floods from many branches, early in the process of concentration, in time for effective warnings. In the third place a special weather forecast service would not only keep touch with the data just mentioned but would give warning in advance of the approach of any storm that might threaten to create a flood on the middle or lower portions of the system when that was already swollen by the arrival of a flood from the north country.

THE CHANNELED SCABLAND OF EASTERN WASHINGTON

J Harlen Bretz
University of Chicago

[With separate map, Pl. VI, facing p. 476]

NO one with an eye for land forms can cross eastern Washington in daylight without encountering and being impressed by the "scabland." Like great scars marring the otherwise fair face of the plateau are these elongated tracts of bare, or nearly bare, black rock carved into mazes of buttes and canyons. Everybody on the plateau knows scabland. It interrupts the wheat lands, parceling them out into hill tracts less than 40 acres to more than 40 square miles in extent. One can neither reach them nor depart from them without crossing some part of the ramifying scabland. Aside from affording a scanty pasturage, scabland is almost without value. The popular name is an expressive metaphor. The scablands are wounds only partially healed—great wounds in the epidermis of soil with which Nature protects the underlying rock.

With eyes only a few feet above the ground the observer today must travel back and forth repeatedly and must record his observations mentally, photographically, by sketch and by map before he can form anything approaching a complete picture. Yet long before the paper bearing these words has yellowed, the average observer, looking down from the air as he crosses the region, will see almost at a glance the picture here drawn by piecing together the ground-level observations of months of work. The region is unique: let the observer take the wings of the morning to the uttermost parts of the earth: he will nowhere find its likeness.

THE THESIS

Conceive of a roughly rectangular area of about 12,000 square miles, which has been tilted up along its northern side and eastern end to produce a regional slope approximately 20 feet to the mile. Consider this slope as the warped surface of a thick, resistant formation, over which lies a cover of unconsolidated materials a few feet to 250 feet thick. A slightly irregular dendritic drainage pattern in maturity has been developed in the weaker materials, but only the major streamways have been eroded into the resistant underlying bed rock. Deep canyons bound the rectangle on the north, west, and south, the two master streams which occupy them converging and joining near the southwestern corner where the downwarping of the region is greatest.

Conceive now that this drainage system of the gently tilted region is entered by glacial waters along more than a hundred miles of its northern high border. The volume of the invading water much exceeds the capacity of the existing streamways. The valleys entered become river channels, they brim over into neighboring ones, and minor divides within the system are crossed in hundreds of places. Many of these divides are trenched to the level of the preëxisting valley floors, others have the weaker superjacent formations entirely swept off for many miles. All told, 2800 square miles of the region are scoured clean onto the basalt bed rock, and 900 square miles are buried in the débris deposited by these great rivers. The topographic features produced during this episode are wholly river-bottom forms or are compounded of river-bottom modifications of the invaded and overswept drainage network of hills and valleys. Hundreds of cataract ledges, of basins and canyons eroded into bed rock, of isolated buttes of the bed rock, of gravel bars piled high above valley floors, and of island hills of the weaker overlying formations are left at the cessation of this episode. No fluviatile plains are formed, no lacustrine flats are deposited, almost no débris is brought into the region with the invading waters. Everywhere the record is of extraordinarily vigorous subfluvial action. The physiographic expression of the region is without parallel; it is unique, this channeled scabland of the Columbia Plateau.[1]

General Features of the Region

In but few regions of comparable area does a single formation have so great a thickness, possess so nearly intact the original surface, and appear so consistently in the relief features as does the Columbia basalt in eastern and central Washington. The plateau is high where the basalt is upwarped, it is low where the basalt is downflexed, it is rough where the basalt is dissected, and relatively smooth where dissection has not occurred. Its main drainage lines are largely consequent on the structure of the basalt, as are its more prominent divides.

The flows of this great formation were originally horizontal. Now, however, there are but few tracts whose underlying flows are not gently tilted or markedly folded. In general, the dip is westward in the eastern part and southward in the western part. Several sharply localized folds occur in the western part, and one in the southeast; elsewhere the warping is so gentle that the terms used for folded structures are not applicable. The drainage pattern faithfully reflects the structure, though it is obvious that not all streams can be consequent. Though the west-flowing Spokane and Columbia rivers skirt the northern edge of the plateau for more than a hundred miles, they receive in this distance the drainage of only about 1300 square miles, so close to their route is the high edge of the gently tilted region. Structure determines the convergence of two-thirds of the entire region's drainage to the Snake and Columbia along its southwestern margin.

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[1] The author's previous writings on this subject include: Glacial Drainage on the Columbia Plateau, *Bull. Geol. Soc. of America*, Vol. 34, 1923, pp. 573–608; The Channeled Scablands of the Columbia Plateau, *Journ. of Geol.*, Vol. 31, 1923, pp. 617–649; The Age of the Spokane Glaciation, *Amer. Journ. of Sci.*, Ser. 5, Vol. 8, 1924, pp. 336–342; The Spokane Flood Beyond the Channeled Scabland, *Journ. of Geol.*, Vol. 33, 1925, pp. 97–115 and 236–259; Channeled Scabland and the Spokane Flood, *Journ. Washington Acad. of Sci.*, Vol. 17, 1927, pp. 200–211 (an abstract and a number of criticisms); What Caused the Spokane Flood?, *Bull. Geol. Soc. of America*, Vol. 38, 1927, p. 107 (abstract presenting the idea that subglacial vulcanism may have been responsible); The Spokane Flood: A Reply, *Journ. of Geol.*, Vol. 35, 1927, pp. 461–468 (answering E. T. McKnight: The Spokane Flood: A Discussion, *ibid.*, pp. 453–460); Alternative Hypotheses for Channeled Scabland, *Journ. of Geol.*, Vol. 36, 1928, pp. 193–223; 312–341.

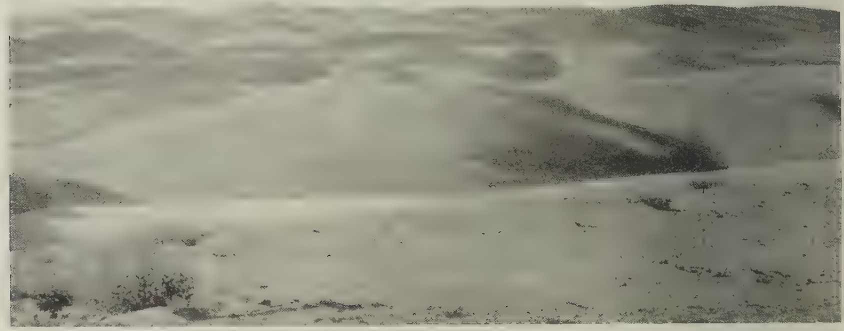

FIG. 1—Mature topography of the loess. (Photograph by Donald Bell.)

Rocks both older and younger than the basalt are elements in the topography of the plateau. The older rocks constitute local elevations, "steptoes,"[2] in the extreme eastern and northern parts of the plateau above the plateau surface. The younger rocks, all sedimentary, are a wide-spread mantle which originally completely covered the basalt. They are composed of piedmont waste, stream gravel, volcanic ash, lacustrine silt, and loess. The loess is much more extensive than all the other deposits. It is deepest in the eastern portion, but in all nearly level parts of the plateau it is deep enough to have been an important item in recording the episode of scabland-making. The essential fact regarding these sediments is that they are all much less resistant than basalt to erosive attack, especially by agents which erode too rapidly for weathering to keep pace and to transform the resistant basalt into incoherent soil. An essential item concerning erosion of the basalt is that, despite its hardness, it is prevailingly cut with the close-set joints of columnar structure. Incipient decay and physical parting extend down these joints far below the depths to which the cores of the columns are decayed.

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[2] I. C. Russell: Geology and Water Resources of Nez Perce County, Idaho, *U. S. Geol. Survey Water Supply Paper 53*, 1901, p. 22.

The rainfall of the plateau today is inadequate to maintain a single permanent and continuous stream from its own run-off. Yet the region is strongly marked almost everywhere by running water. Aside from the scablands and the more strikingly folded tracts, this stream-determined topography expresses maturity of dissection (Fig. 1). In the eastern part of the region, where the loessial mantle is from 100 to 300 feet thick, the smaller valleys are entirely in loess. The larger ones, more deeply eroded, have their lower portions in basalt and are more youthful in appearance. Their canyon-like characters are due unquestionably in part to the greater resistance of the basalt, but evidence is not lacking to suggest that much of the mature aspect of the plateau may antedate uplift.

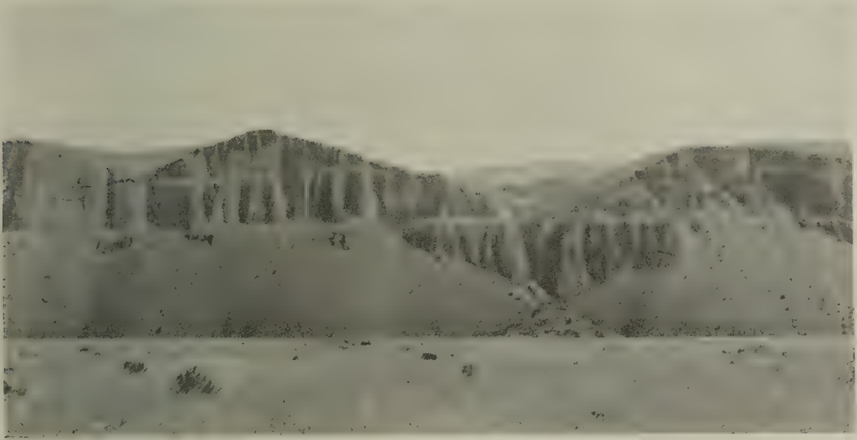

FIG. 2—Eastern wall of Moses Coulee at its mouth. Minor tributaries of the preglacial valley left hanging. Cliff summit 850 feet above coulee floor. (Photograph by L. C. Robinson.)

In addition to the mature slopes of the loess mantle and the canyon-like larger valleys on and bounding the plateau, the marks of running water include the scablands. These scabland tracts are exceedingly youthful features and are distributed along almost every drainage line from the northern high edge of the plateau sufficiently important to bear a local name. Yet in large part the scablands are not valleys. Some scabland tracts are completely lacking in valleys; some include several valleys, the separating divides themselves definitely scabland; some scabland tracts which for miles follow valley courses have margining scabland above the valley walls as wide as, or even wider than, the valley itself.

With but one exception, all valleys in the scabland have some tributaries from adjacent maturely dissected loess-covered country.

Except at and near their entrance to the greatly eroded scablands, these tributaries lack all trace of either the erosional or depositional modifications that produced the scablands. Their almost unvarying accordant junction with the valleys in the scabland indicate that those severely scoured valleys existed in present dimensions before the ravaging glacial waters entered.

All of the scabland drainage ways are united in a most remarkable anastomosing pattern. The convergences in this pattern clearly were inherited from the preëxisting drainage system. But the divergences, equally numerous, are the consequence of a flooding of the preglacial valleys so great that the minor divides, even some of the major divides, of the plateau were crossed, and adjacent routes were entered. Some of the routes thus entered were carrying glacial water from the ice edge. Others did not head far enough north and, without this flooding, never could have shared in the episode. Pronounced divergences took origin more than 50 miles in a direct line from the edge of the ice. It is nothing short of amazing to find that some of these divergences required rivers 200, 300, and even 400 feet deep: not ponded conditions of that depth, but vigorously flowing rivers.

Four Major Tracts of Scabland

In terms of separate origin on the northern high part of the plateau, the youthful scabland areas are resolvable into four different portions. The greatest of these is the easternmost. It heads in the general region of Cheney, 20 miles southwest of Spokane, and enters Snake River Canyon with the drainage of the Palouse River system. It may therefore be termed the Cheney-Palouse River tract. The next spillway group to the west, the Telford-Crab Creek tract, heads in the vicinity of Telford station, about 40 miles from Cheney. The third is Grand Coulee, a single great canyon across the divide, 40 miles west of Telford. The fourth and westernmost is Moses Coulee, also a separate canyoned route but heading on the southern slope of the plateau instead of crossing the divide.

The Cheney-Palouse River tract is 75 miles long and about 20 miles wide. Not one-fifth of it is occupied by loessial islands, though it was all covered with loess before the glacial discharge occurred. Several streams enter it from loess-covered country to the east, and one stream, Cow Creek, has its entire drainage area within the scabland tract. The wide spreading of the glacial waters is strikingly shown by this extensive scabland and its seventy-odd loessial islands. Yet more striking is the existence of eight well-marked subsidiary spillways which diverged from the west side of the Cheney-Palouse River tract at distances from the ice edge ranging from 3 to 60 miles. All these required operation of the major dischargeway for their own functioning; all were unquestionably contemporaneous at their initiation; no succession of operation could possibly have occurred by change in position of the glacial margin.

The Telford-Crab Creek scabland tract, next to the west, is as wide as the Cheney-Palouse River tract, but it loses its unity about 15 miles south of the plateau divide because of the number and capacity of divergent channels. However, convergence of all these (and of all but one of the Cheney-Palouse River divergences) occurs in a wide shallow structural sag (Quincy Basin) in the western part of the plateau. In this basin is the largest single area of gravel left by the glacial waters. It covers at least 24 townships. That all the channels of this Telford-Crab Creek spillway were in operation at one time cannot be gainsaid. There is continuous scabland northward from all channel heads of this tract across the plateau divide to the limits reached by the ice sheet. Some 40 to 50 square miles of this drain northward to the Columbia at present and did so in preglacial time; yet they clearly carried a wide, south-flowing sheet of glacial water to supply all the divergent channels.

Both Grand Coulee and Moses Coulee are canyons with maximum depths of 900 to 1000 feet (Fig. 2). The canyon character of these tracts is due to greater structural gradients of this part of the plateau. In both, there were preëxistent stream canyons (except in the northernmost 20 miles of Grand Coulee), but in both there was great deepening and widening by the glacial waters. Grand Coulee discharged a broad divergent sheet of water southeastward from its southern portion, but Moses Coulee had no divergences.

Causal Conditions Obtaining Over the Area

The anastomosing habit of scabland tracts over the entire area demands causal conditions that likewise existed over the whole region. These conditions were essentially:

1. A volume of glacial water too great for the existing valleys to carry.
2. A marked contrast in erodibility of the loess and basalt.
3. A high gradient for streams of the volume indicated by the abandoned channels.

Nowhere does the field evidence suggest any other cause, nowhere is it inconsistent with this explanation, and almost nowhere does it fail to show several mutually corroborative phenomena in support of this explanation.

More than 50 well-defined cases of divergence across loess-covered divides are known and at least three cases where such divides, parallel with (instead of transverse to) the direction of flow, were destroyed for 15 to 45 miles between the preglacial valley courses. In eight places the divide crossings in the anastomosis were notably eroded in basalt. The most striking case is the diversion of Palouse River from its preglacial valley (Washtucna Coulee) to a very narrow canyon (Palouse Canyon) and the consequent shortening of the river by about 40 miles. Palouse Canyon (the lower ten miles of the river) is 400 to 800 feet deep in basalt (Figs. 3, 4, 5). Part of it is modified from a short preglacial tributary to the Snake, but the very narrow straight portion across the old divide clearly is a product of the Cheney-Palouse River discharge. A waterfall 196 feet high still survives in this canyon (Fig. 6).

Palouse Canyon is not the only record of the breaching of the divide. The whole summit for ten miles from east to west (transverse to the canyon) is marked scabland. It reaches 350 feet above the floor of the abandoned valley and 800 feet above the bottom of Snake River canyon to the south. Yet both valleys are preglacial. And in both

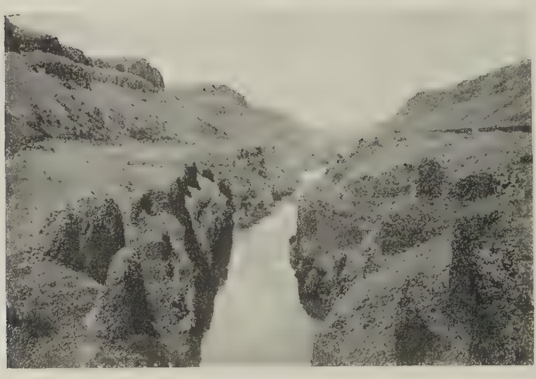

FIG. 3

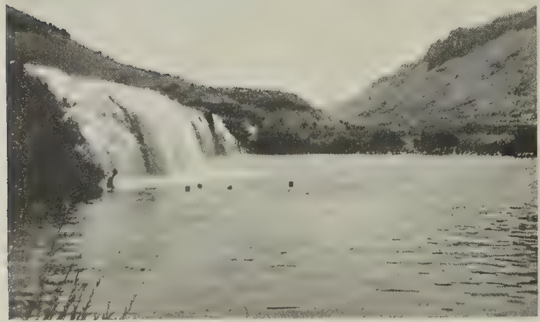

FIG. 4

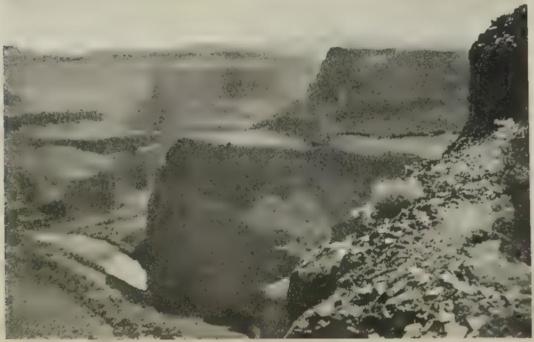

FIG. 5

FIG. 3—Palouse Canyon between the two falls across the former Palouse-Snake divide. Cut about 400 feet deep. Looking north into the preglacial valley.

FIG. 4—Upper Palouse Falls. Close to the divergence from the preglacial valley.

FIG. 5—Palouse Canyon below the lower falls. Portion modified from a short preglacial tributary of Snake River. Rounded relict hill of loess on sky line.

the water flowed vigorously westward and southwestward toward the Columbia.

All scabland areas descend toward Snake River or Columbia River and enter these large valleys. Here the effect of the glacial waters might presumably be indistinguishable from the work of these two rivers before and since the scabland-making episode. Such a presumption would be based on the conception of these river valleys as valleys also for the glacial streams. The river-channel characters, the key to scabland interpretation, would give place to normal valley characters. It should then follow that the extraordinary anastomosis on the plateau was the consequence of shallow streams (for their widths cannot be disputed) or that there was sequence, not synchrony, in their operation. If the great widths and great depths actually existed contemporaneously in all channelways, both the Snake and the Columbia should similarly have become channels. They should have developed some cases of divergence in consequence of the flooded condition, and their tributary valleys which did not head in the scabland should have been notably ponded by the great volume. This is a crucial test of the writer's thesis.

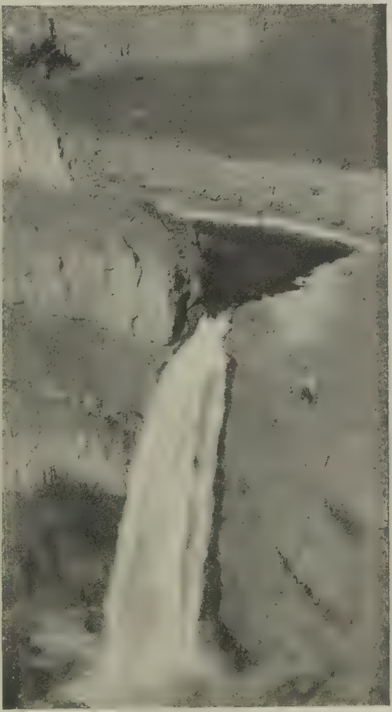

FIG. 6—Lower Palouse Falls, 196 feet high. (Photograph by L. C. Robinson.)

The valley system of southeastern Washington is older than any scabland. This is amply attested by the graded slopes, the development of tributary systems, the relations of loess to scabland, and the presence of old stained gravels in valley bottoms. In many places on the plateau it is clear that the scabland features are superposed on this older drainage pattern in loess and basalt. Palouse Valley, for example, was as deeply entrenched in basalt east of the scabland as it is today; and, if a dam 100 feet high were built at the head of the canyon through the divide, the abandoned route (Washtucna Coulee) would be resumed. This abandoned preglacial course, now without drainage, is more than 40 miles long and 200 to 350 feet deep in basalt (Fig. 7). Minor tributaries from a large loess-covered tract to the north join it at accordant grade, yet belong to the pre-scabland mature drainage system.

There were eight different entrances of the scabland rivers to the Snake and Columbia valleys, one of them multiple. Three of them, entering the Columbia, are over precipices 200 to 400 feet high (Fig. 8), and two of them, entering the Snake, are very narrow canyons across the preglacial Snake-Palouse divide (Fig. 9). Judged by the criteria of an accordant junction and a system of pre-scabland tributaries, the only scabland routes entering the master valleys that were inherited from the older drainage system are Moses Coulee, Crab Creek, and Palouse River (via Washtucna Coulee).

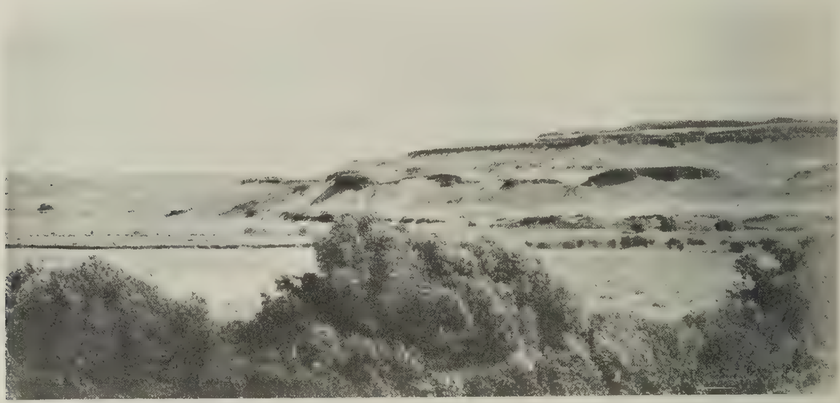

FIG. 7—Washtucna Coulee at Washtucna Lake. Scabland walls well shown. Compare this abandoned valley of the Palouse River with the canyon it now occupies. (Photograph by Robert Landon.)

Deposits in the channeled scabland system constitute another remarkable feature. There are two kinds; the channel deposits, prevailingly of pebbles, cobbles, and boulders, and the pond deposits back in valleys entering the scabland from unglaciated areas. This classification is not a rigid one, however, for in some places a ponded condition succeeded current flow.

The gravel deposits in the channels depart as much from conventional valley fills as the scablands do from valley forms. They are so situated with reference to the canyoned channels and the rock basins that they cannot be remnants of valley trains or similar deposits unless two episodes of enormous discharge be postulated. Their shapes are such that by no possibility can they be erosional in origin. They are local deposits, built beneath the surfaces of the great rivers. As channel deposits, they are contemporaneous with the erosional forms in basalt and in loess. Many of them are hills a hundred feet in height, some of them are 200, 300, and even 400 feet above their lower base. There is no term in geological literature for them except that of "bars" (Fig. 10). Their locations are all in conformity with the genesis implied by that term, as also are their structures, their shapes, and their composition. But if they are bars, the glacial streams in which they grew far exceeded any other glacial streams in depth. Were this conception of great depth based alone on these so-called bars, it could command but little respect. Rivers of this character must have left other evidence. Some of that evidence has already been briefly reviewed. The great widths shown on the map are undeniable, the physiographically recent great scouring of the basalt over hundreds of square miles is almost startling, the scarped islands of loess still carrying the mature topography of pre-scabland time are indisputable. And such divide crossings as Palouse Canyon, formed while the preglacial valley a mile wide and 350 feet deep was carrying a great stream away from the threatened divide, offer strong corroborative evidence. But there is still more evidence of the flooded condition of the valleys of eastern Washington. It lies in the other type of deposit noted, the silt and sand of the ponded tracts.

A generalization to which no exceptions have yet been found is that every non-scabland valley entering the scabland contains débris carried back into it from the scabland. This débris may consist of scattered erratic boulders, cobbles, and pebbles; or of stratified silt and sand; or it may be a gravel deposit partially blocking the entrance. All three types are found in many of these valleys. The erratic character of some of the débris is not limited to the larger fragments, it is to be recognized even in the sand deposits. And some remarkable lenses of berg-laid till in the stratified sand and silt have been found.

These features are common in valleys that receive and always have received their run-off entirely from loess and basalt. In each valley the records above listed occur only up to an altitude corresponding to the upper limit of the glacial waters where that valley opens into the scabland complex (Fig. 11). The two most notable cases of ponding yet found are in Snake[3] and Walla Walla valleys. In Snake Valley, the upper limit of erratic cobbles and boulders and of stratified silt and sand is 1350 feet A. T., and the altitude reached by the glacial flood across the Palouse-Snake divide is 1325 to 1350. At the entrance of the adjacent Walla Walla Valley, 40 miles farther down the Snake, the upper limit of the glacial waters was about 1100 feet A. T., and the deposits under discussion are known up to 1080. Maximum depths of the two ponds thus recorded are about 800 feet each.

These records of ponded waters are not topographically expressed except at the very entrance of the tributary valleys into the scabland. Gravel deposits here commonly have the form of embankments which, when built, partially or even completely blocked the tributary valleys. Elsewhere the materials generally constitute a mantle on all slopes below the upper limit, thicker on lower slopes but easily overlooked if one passes through by train or automobile. In contrast, the great mounded channel deposits are almost as spectacular as the associated basalt scabland.

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[3] East of the entrance of Palouse River.

The junction of the two master valleys, the Snake and the Columbia, in the southwestern part of the river-scarred plateau is 120 miles by direct scabland routes from the head of the Cheney-Palouse River spillway and 140 miles from the Telford-Crab Creek spillway head. All glacial waters of the anastomosis converged here and escaped thence to the Pacific along the lower Columbia. The junction occurs in a wide structural valley where there is very little scabland but a large area carrying huge gravel mounds. Nineteen townships are covered deeply with this débris. The criteria by which the mounded gravel deposits in the scabland are adjudged glacial river bars lead to the same conclusion here. The relations between these bar deposits and their basin differ somewhat from the relations in the Quincy Basin up on the plateau. These 100-foot to 400-foot gravel mounds, though clearly having constructional profiles, have steeper slopes and better-

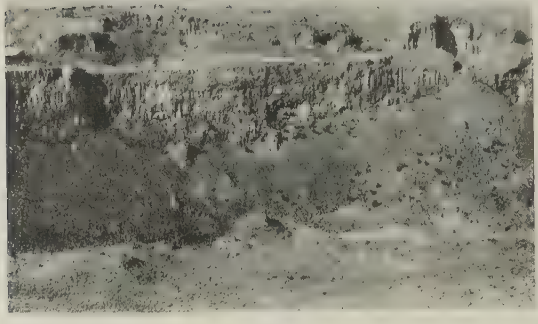

FIG. 8

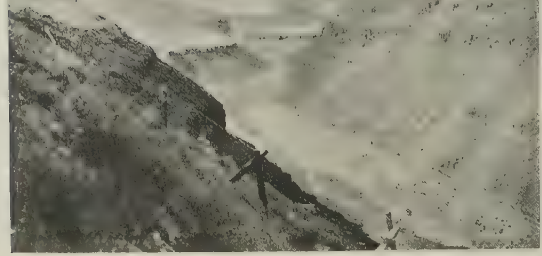

FIG. 9

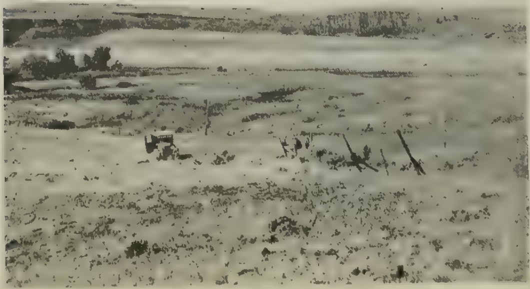

FIG. 10

FIG. 8—Frenchman Springs Cataract. A western spillway from Quincy Basin. The total height of the irregular cliff is 400 feet.

FIG. 9—Devils Canyon. A narrow gash across a preglacial divide. No stream other than local run-off has used it since it was formed.

FIG. 10—Bar in Crab Creek Valley, south of Downs. Except at the left, a partially enclosed depression lies between the bar and the cliff.

marked river channels among them. They more nearly approximate river bars in appearance, as a scrutiny of the generalized contour lines on them (Pl. VI) will show. And they almost nowhere approach the upper limits or the outer limits of the glacial waters. In Quincy Basin, along the Telford-Crab Creek spillway group, they closely approach or actually reach both. This basin had but one outlet; the Quincy Basin had four. Scabland on the walls of this outlet (Wallula Gateway) is perfectly definite up to 1150 feet A. T. and probably extends to 1200 (Fig. 12). This gap is cut across an asymmetrical fold 12 miles south of the Snake-Columbia junction, a fold which constitutes the south wall of the structural valley. If Wallula Gateway was approximately as deep in preglacial times as at present[4] the waters flowing through it during the scabland-making episode were nearly 900 feet deep.

Obviously, another explanation is at hand

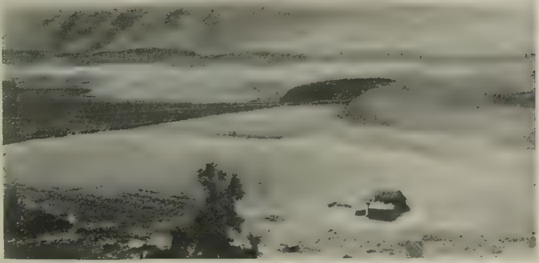

FIG. 11

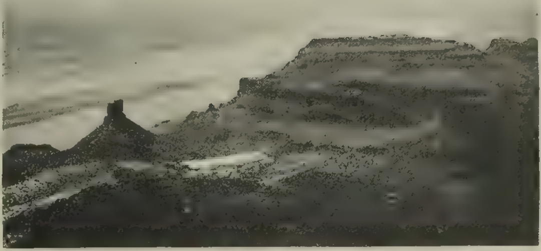

FIG. 12

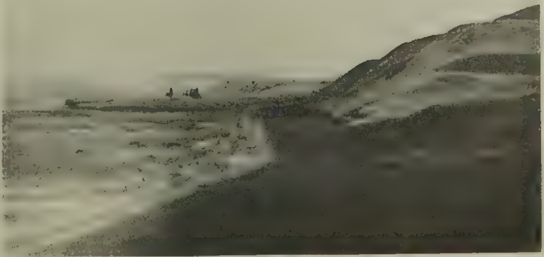

FIG. 13

FIG. 11—Terrace in Touchet River valley, tributary of the Walla Walla River. (Photograph by Robert Landon.)

FIG. 12—Scabland on east wall of Wallula Gateway. Smaller butte 300 feet, larger butte 450 feet above river.

FIG. 13—Near Celilo, Ore. Scarp eroded in ancient gravel formation; scabland at base a rock terrace 500 feet above the Columbia.

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[4] New data seem to show this. Earlier interpretations called for considerable deepening by the glacial waters.

for the 900-foot vertical range of the marked scabland of the Gateway—that the upper scabland is older; so much older that it antedates the present depth of the canyon across the anticline. The evidence for a full development of the valley system draining the plateau before the glacial flood occurred has been outlined. The alternative hypothesis apparently cannot be harmonized with it. But before the matter be considered closed, the valley of the Columbia beyond the Gateway should be examined. Its character must have an important bearing on the problem.

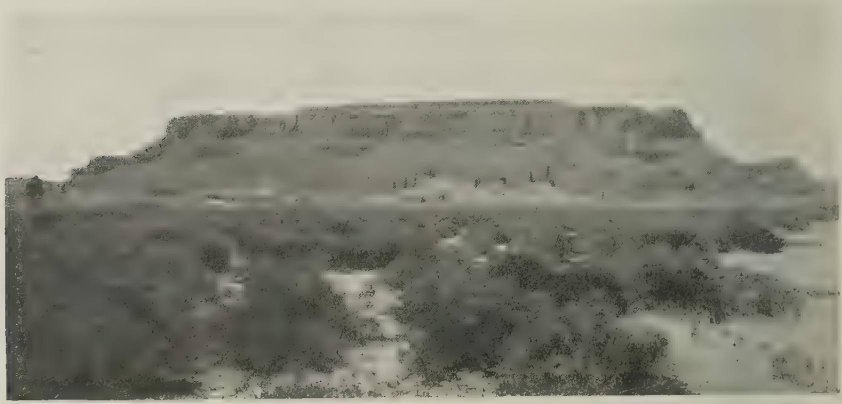

FIG. 14—Steamboat Rock, in the middle of upper Grand Coulee. The largest mid-channel butte of the scabland. (Photograph by C. L. Beane.)

CHANNELED SCABLAND BEYOND THE PLATEAU

From Wallula Gateway to the Willamette River, west of the Cascade Range and 200 miles beyond the Gateway, the Columbia basalt is the physiographically dominant formation. The plateau is generally considered to extend westward to the Cascade Range, but it is considerably more warped and folded than in eastern Washington. In a general analysis three portions may be recognized along the river: two downwarped areas separated by an area of upwarp. The river valley in the downwarps is wide and without notable walls; across the upwarp it is a canyon with maximum depth of a thousand feet. Across the folds of the Cascade Range farther west it is a great canyon or "gorge" 4000 feet in maximum depth; and still farther west, about Portland, there is a great widening which probably is largely structural.

The "wides" and "narrows" along 200 miles of Columbia River below the junction of the Snake have almost the same modifications that are found in similar situations above that junction. The wides carry great gravel deposits with bar forms almost intact. The stratification in these bars dips prevailingly away from the Columbia. The material is commonly but little worn, is poorly sorted, and is almost all local in origin. Striking contrast exists between present Columbia River gravel and this bar material. The bars are not all spread out in the structural wides, many are built in reëntrants in the walls of the canyoned portions. Some are built high above the river, some extend almost from river level up to heights as great as 400 feet. Mouths of tributary valleys are favorite places for them; their form, composition, and structure indicating clearly that they were built by the greatly swollen Columbia, not by the tributary streams. Not one of these deposits can be explained as old stream gravels left during the deepening of Columbia Valley, or as recording former valley trains, without doing violence to the field evidence. No other river valley in the world possesses such features, so far as the writer has been able to learn. Like those on the plateau above the junction of Snake River they are channel forms, not valley forms.

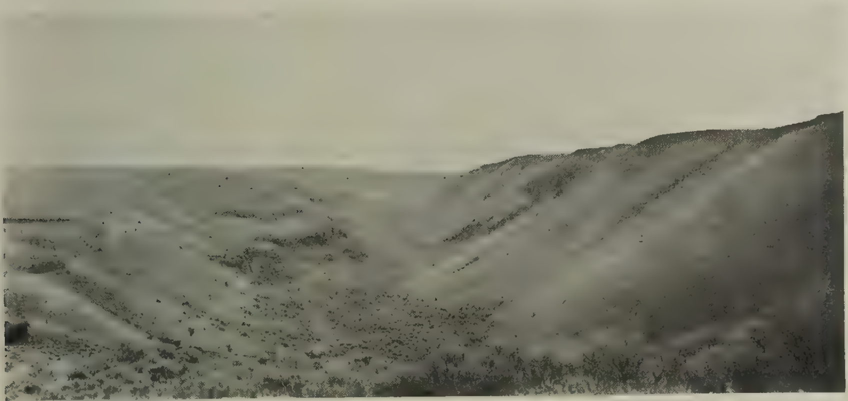

FIG. 15—Head of Spring Coulee, a divergent canyon leading southeastward out of lower Grand Coulee. (Photograph by L. C. Robinson.)

As with the depositional part of the record, so with the erosional part. There are channels, rock basins, and buttes of very youthful character, eroded in basalt, at high levels above the Columbia. They are river bottom features. They assuredly do not date back to the original cutting of the Columbia Valley. Their occurrence as actual divergences from the Columbia across divides to tributary valleys, and the building at such places in the tributary valleys of great bar dams or partial dams, demand the same extraordinary relations of volume to capacity as in the scabland system on the plateau.

The erosional features are most pronounced in the narrows. Where the contact of weaker formations on basalt was reached by the immense glacial river the overlying material was swept off to produce a broad basalt terrace, etched with the characteristic vigorous strokes and margined by a youthful scarp in the superjacent formation (Fig. 13). To build these great bars in the lower Columbia Valley, to erode the high-level scabland and its margining scarps, and to allow the divergences into the lower courses of tributaries demand depths but little less than those at Wallula Gateway and in Snake River Canyon. A remarkable combination of all these features near the mouth of John Day River records 750 feet of flowing water in the Columbia.

The record of the great glacial river has been found as far down the Columbia as Portland, Ore. Here it appears to end in a deltaic gravel deposit which covers about 150 square miles. The surface of the deposit ranges from river level (which is nearly sea level) up to 360 feet A. T. Most of it lies above 200 feet. It is not a plane surface, and its irregularities are not due to erosion since the deposit was made. Though the structure everywhere is foreset, the direction of dip is so diverse in some places that, taken with the absence of a plane surface, it does not conform to the conception of a delta. A specific explanation for the ensemble would be difficult if one had no acquaintance with channeled scabland and its bars. But for the requirements of that explanation, the Portland Delta is ideal. It is a great assemblage of bars and channels, correctly disposed and constructed for the aggraded floor of a huge river here losing its current at the head of a broad drowned valley. The detailed relations to certain rock hills which are surrounded by the deposit are incapable of any other explanation than that of subfluvial origin of the whole deposit.

Erosional Forms in Basalt

The realization that a remarkable episode of glacial history was recorded in eastern and central Washington first came from an attempt to map and explain the bizarre erosional forms on the plateau surface. Running water, not of local origin, was clearly indicated as the map grew. Surviving areas of the earlier topography, a normal drainage pattern, were available everywhere for comparison. Certain unusual forms in the scabland and certain relationships in its pattern early led to the conception of prodigious streams. This conception demanded the existence of other features and relationships which had not yet been recognized, and it afforded a clue to the origin of some features which in themselves did not so strikingly tell of great volume. The development of the hypothesis has continually led to the finding of new field relations and new criteria, all of them consistent with the explanation, none of them pointing to any other interpretation. Furthermore, essentially every kind of evidence required by the hypothesis has now been found.

In the remainder of this paper, a genetic classification of the physiographic forms of channeled scabland will be presented.

CANYONS: GRAND COULEE

The empty canyons and dry cataracts of the plateau are easily the most conspicuous scabland forms. Among the canyons Grand Coulee takes precedence, followed by Moses Coulee. Grand Coulee has many times been explained as a former course of the Columbia across the plateau.[5] For a time it was considered to have been initiated by a great fissure,[6] and this idea was built into the first interpretation of the coulee as a glacially diverted Columbia.[7] Grand Coulee is nearly 50 miles long. It has an upper canyoned part about 28 miles long, a short stretch in mid-length across a structural sag (Hartline Basin), and a lower canyon about 20 miles long. At least four definite upfolds in the basalt are recognizable across the coulee, their existence conditioning the variations in character and the divergences.

Upper Grand Coulee is a simple canyon whose average depth is perhaps 900 feet. The width of its floor is nowhere less than a mile and a half and in one place is nearly five miles. In the middle of this wide place stands Steamboat Rock, a butte of basalt a square mile in summit area and 800 to 900 feet high (Fig. 14). Its summit is a part of the original plateau surface, now trenched by this glacial river canyon. Like the margining cliff summits, its top is marked by scabland buttes and channelings in basalt.

Lower Grand Coulee begins with a very irregular abandoned waterfall, 400 feet high, over nearly horizontal basalt flows. Most of the lower coulee, however, is eroded in tilted flows, along a monoclinal fold whose eastward dip is responsible for lower cliffs on that side. At least five pronounced divergent canyons lead southward and eastward out of the lower coulee and the mid-length structural basin (Fig. 15). All cross the minor upfolds of the basalt here. The head of the lowest of these is about 200 feet above the adjacent floor of Grand Coulee.

Grand Coulee is a part of the Crab Creek drainage system, but today it is a closed basin. Its lowest place, Soap Lake at the south end of the lower coulee, is shut in on the south by extensive gravel deposits. The lower coulee is made over from a preglacial drainage line out of the structural sag. Tributary furrows on the monoclinal slope to the west, expressing the general maturity of the plateau, hang hundreds of feet above the surface of the lakes on the coulee floor. The preglacial eastern wall, however, has been almost completely overrun by glacial waters and is striking scabland.

The upper coulee apparently is a glacial river canyon *de novo.*

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[5] The earliest published suggestion of this appears attributable to Samuel Parker, who crossed the Grand Coulee in 1835. In his "Journal of an Exploring Tour Beyond the Rocky Mountains," Ithaca, N. Y., 1838, he speaks of the "Grand Coulé, which was undubitably the former channel of the river [Columbia]," p. 294.

[6] Probably first suggested by T. W. Symons in "The Upper Columbia River and the Great Plain of the Columbia," *47th Congr., 1st Sess., Senate Ex. Doc. No. 186*, 1882.

[7] I. C. Russell: A Geological Reconnaissance in Central Washington, *U. S. Geol. Survey Bull. 108*, 1893.

Unlike the lower coulee, its walls have no notches where preglacial drainage furrows hang above the bottom and therefore no rounded gable-like headlands in the upper profile. It is also unlike the other two scabland channel routes across the plateau divide (Cheney-Palouse River and Telford-Crab Creek) in that it is deeply entrenched. The others show scarified basalt over wide tracts, but the chief result of glacial waters in them was to carry away the overlying loess. The upper limit of glacial water at the head of the Grand Coulee route is essentially the same as in the other two (2500 to 2550 feet A. T.), but the floor is nearly a thousand feet lower than in either of them. There are at least two reasons for this. The original spill across to the mid-coulee structural sag descended the monoclinal slope already noted. This afforded an initial descent of nearly a thousand feet in a very few miles, and the great river probably sloped back rapidly to cut the canyon. Furthermore, the coulee was in use in a later glacial episode than the one to which the rest of the scabland is ascribed. The ice of this later episode did not cross the Spokane and Columbia valleys east of the head of Grand Coulee, though to the west it advanced farther than the earlier ice sheet. Apparently Grand Coulee had already been deepened considerably in excess of the other routes and thus functioned alone across the plateau divide during this later episode. Some deepening probably occurred at this time.

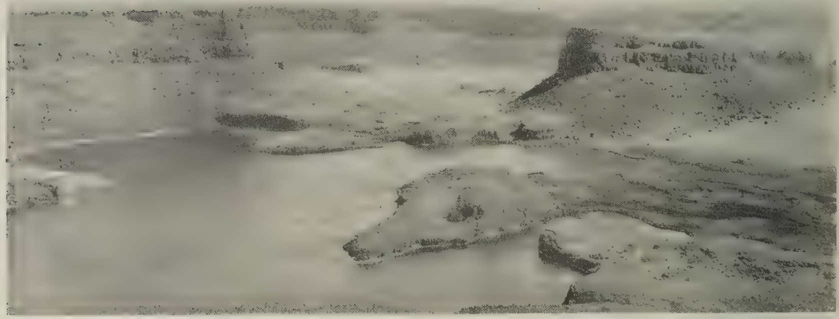

FIG. 16—Part of "Dry Falls," the abandoned cataract in Grand Coulee. Summit of cliff is 400 feet above the plunge basin lake. This cataract was in use during a later episode of glacial diversion. Looking northeastward into Hartline Basin. Battleship Rock on right. (Photograph by C. L. Beane.)

The upper part of Grand Coulee, therefore, shows the following characteristic features of the canyons eroded entirely by glacial rivers on the plateau.

1. It crosses a preglacial divide. Though not an essential character, this is the prevailing relation to divides.

2. It possesses scabland on the "rim rock," above and behind the brink of the cliffs. Every canyon shows this, though not necessarily along its entire length.

3. It has steepened slopes in the loess or other sediment overlying the basalt. These are present wherever scabland occurs above the brink of the canyon walls.

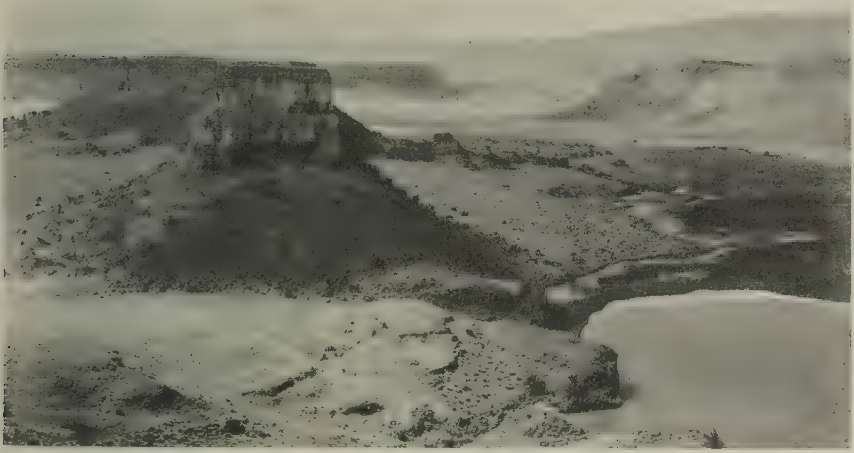

FIG. 17—Head of lower Grand Coulee looking south from the brink of the old cataract. Pothole Lake at right, Battleship Rock in middle left of the view. The monocline which constitutes the west wall of the lower coulee determines the sky line. (Photograph by E. J. Evans.)

4. It has islands of loess on this upper scabland. They are found on all such scabland.

5. It has island buttes of basalt in mid-canyon.

Lower Grand Coulee lacks only the location on a preglacial divide. It shows some additional features that surely were not inherited from the preglacial drainage route.

1. Rock basins on the floor are numerous. All glacial river trenches in the scabland possess these features, except perhaps upper Grand Coulee.[8]

2. A large trans-coulee cataract exists. Most of these glacial river canyon trenches have more than one, though large cataracts also exist outside of the canyons.

3. There are several striking canyons diverging from the main canyon. These are really minor divide crossings in themselves.

Moses Coulee best illustrates one feature of these canyons, the remarkable deepening and widening locally produced in the preglacial routes. Douglas Creek, an affluent which enters the coulee 15 miles above the Columbia, may well be considered the major streamway, not the tributary, of the preglacial pattern; but its headwaters were not entered at the time the coulee carried a glacial river, and as a consequence the deepening and widening of the coulee left Douglas Creek Valley hanging 350 feet above the gravel fill in the coulee bottom. Wells show the fill to be more than 200 feet deep, and the amount of "hang" is correspondingly increased. Widening of Moses Coulee is responsible for perhaps a hundred feet of this total of 550 feet. Douglas Creek, though a permanent stream, has gashed the lip of the hanging valley for less than a mile back during all post-trenching time. Since the later ice sheet discharged but little water through Moses Coulee, the slow rate of normal valley deepening, compared with the rate of glacial stream canyoning, is obvious.

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[8] The floor of the upper coulee is covered with gravel and silt; and, if there are rock basins here, they are buried.

Cataracts and Cascades

Their name is legion. Scarcely a scabland area is without ledges transverse to its length. In some places, whole series of them are in sight from well-chosen viewpoints. Most of them have rock basins at their base, commonly empty basins. Those less than 20 feet high are almost negligible in developing the argument, so common are those of larger dimensions. Sheer descent of their full height is rare, though Palouse Canyon has one 196 feet high (now carrying Palouse River), Grand Coulee's abandoned falls (Fig. 16) are 400 feet high, and Quincy Basin has three such spillways out of the western part, with vertical transverse cliffs 200, 400, and 400 feet in maximum height. In most cases the glacial rivers descended in gigantic cascades, Moses Coulee having a complex one a mile wide and a mile long, in which the descent was 400 feet.[9]

Recession of these cataracts and cascades left canyons that may be mere niches or recesses in the basalt wall over which the water fell or that may be miles in length. Many of the smaller ones came into existence only through the sweeping off of the loess and the uncovering of buried basalt ledges of the pre-loessial topography. Staircase Rapids, near Washtucna, is an example.

Among these cataracts there were a few double falls each member of which receded at approximately the same rate, so that the island in mid-channel became very much elongated, like a great blade, as the falls receded and the canyons lengthened. Potholes Cataract, one of the three western spillways out of Quincy Basin, has the most striking mid-cataract blade. It is a mile and a half long, a quarter of a mile in maximum width at the base, and its cliffs are from 100 to 275 feet high (Fig. 18).

It seems entirely probable that upper Grand Coulee was cut through the divide by the stoping of cataracts or cascades down the steep monocline north of the structural Hartline Basin. Steamboat

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[9] Not 600 feet, as previously reported by the writer.

Rock thus would be explained as a Goat Island around which both falls retreated to unite again as one and thus to isolate it. An actual case of this sort is Battleship Rock which stands just in front of the great cataract at the head of the lower coulee (Fig. 17). Another illustration of canyon-making by cascade-stoping is Devils Canyon, a short spillway from Washtucna Coulee to the Snake, 15 miles west of Palouse Canyon.

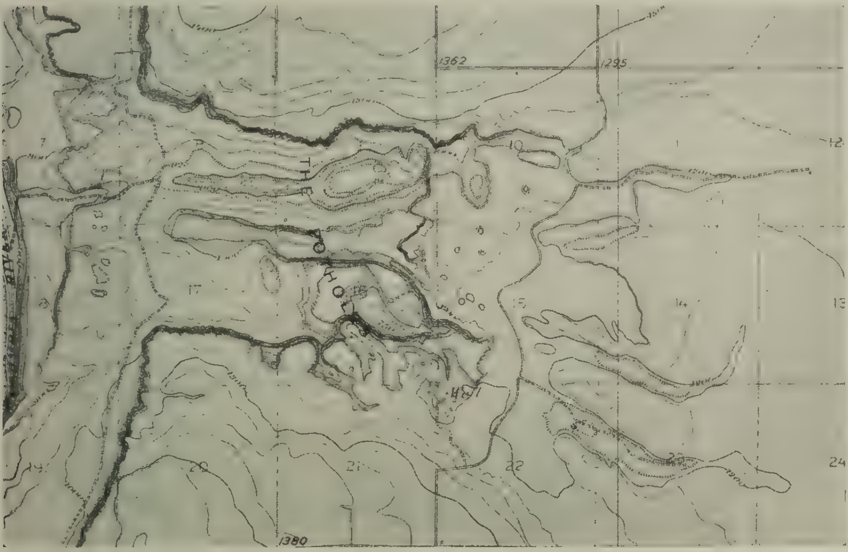


FIG. 18—Potholes Cataract, one of three cataract spillways from the west side of Quincy Basin. (From Quincy sheet, U. S. Geological Survey.)

ROCK BASINS AND MID-CHANNEL BUTTES

There is no feature of channeled scabland more challenging than the rock basins. There are thousands of them, from shallow saucers to the great canyoned basin of Rock Lake on the eastern margin of the Cheney-Palouse River spillway, more than seven miles long and having a reported depth of 250 feet near its northern end. The rock basins are not limited to the canyons and the cascade chutes or the foot of cataracts. They occur in great profusion on the broad uncanyoned heads of the two eastern scabland tracts. They occur on the torrent-swept summit of the Palouse-Snake divide, on the slopes of the preglacial valleys involved in the scabland discharge, and on the scabland benches above the rim rock of these preglacial valleys. Though not the only closed depressions left in the area after the scabland-making episode, they are the most common.

Most of the basins in the eastern and northern higher part of the plateau contain lakes and swamps today. Farther southwest, where the rainfall is less, many are empty most of the year. Some of these empty rock basins are 200 feet deep, though they have been receiving wash ever since the glacial flood subsided. Many are so steep-walled that they can be entered only at favorable places, and the bottoms of a few are accessible only by rope or ladder. The steepness of their walls is comparable to that of the associated canyon walls and butte walls and has the same explanation. Both have their slopes determined by the character of the basalt. Where that has large, well-developed columnar structure (and where glacial rivers had adequate gradient) slopes are steepest: where this structure is absent or poorly developed, the rock basins have gentler slopes.

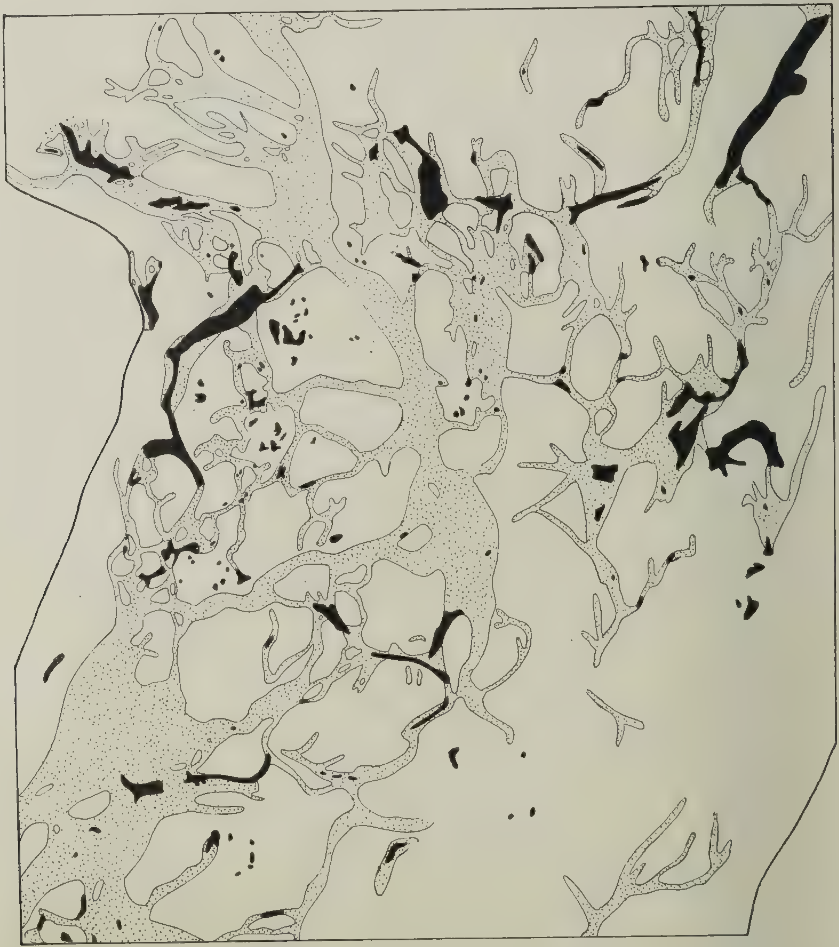


FIG. 19—Channels, rock basins, buttes, and general scabland of a part of the Drumheller Channels. Rock basins black, channels stippled, buttes and general scabland blank. The beginning and ending of many channels in the plexus is better shown here than on the contour map, Figure 21, as also is the extreme irregularity of the channel pattern. The larger rock basins are notably linear and are largely in channels. It must be understood, however, that the highest scabland is itself channel floor of the great spillway. Scale approximately 1:120,000, slightly more than half an inch to a mile.

Buttes in mid-channel are far more numerous than abandoned cascades and cataracts, and most of them cannot have been formed by cataract recession. The association of isolated hills and hillocks of basalt with rock basins in the scabland channels is characteristic. Where the rock basins are deep, the buttes are prominent. Though one

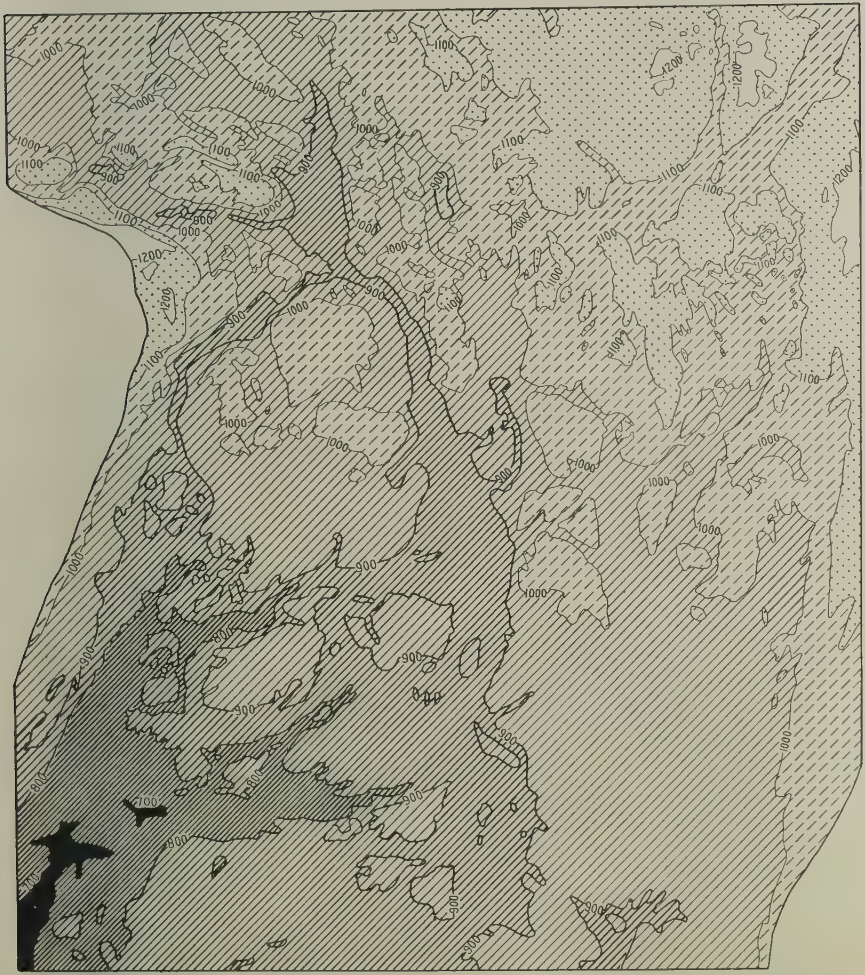


FIG. 20—Hypsometric map of a part of Drumheller Channels. Distribution of higher and lower tracts is more graphically shown than by the intricate and unusual contour pattern of the map, Figure 21. The contour interval is 100 feet. The highest areas (blank) are over 1200 feet; the lowest (solid black) less than 700 feet A.T. Comparison with Figure 19 will show the location of several of the largest (including the deepest) rock basins and many of the channels on the higher part of the scabland plexus.

is the reverse of the other, they are genetically associated forms. The conditions that gave rise to one produced the other. The maximum depth of erosion by glacial waters in any one place is the sum of butte height and basin depth. In such tracts the spacing of buttes and basins is very close.

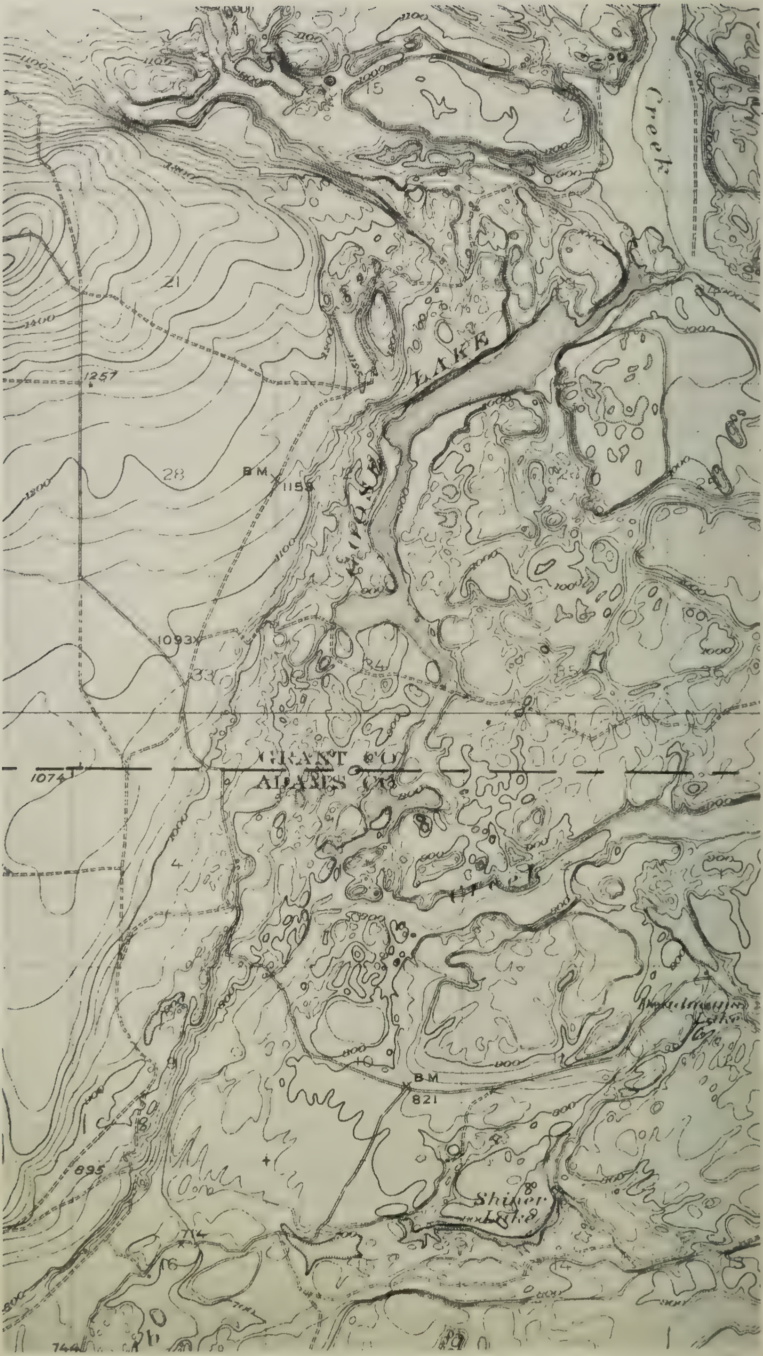
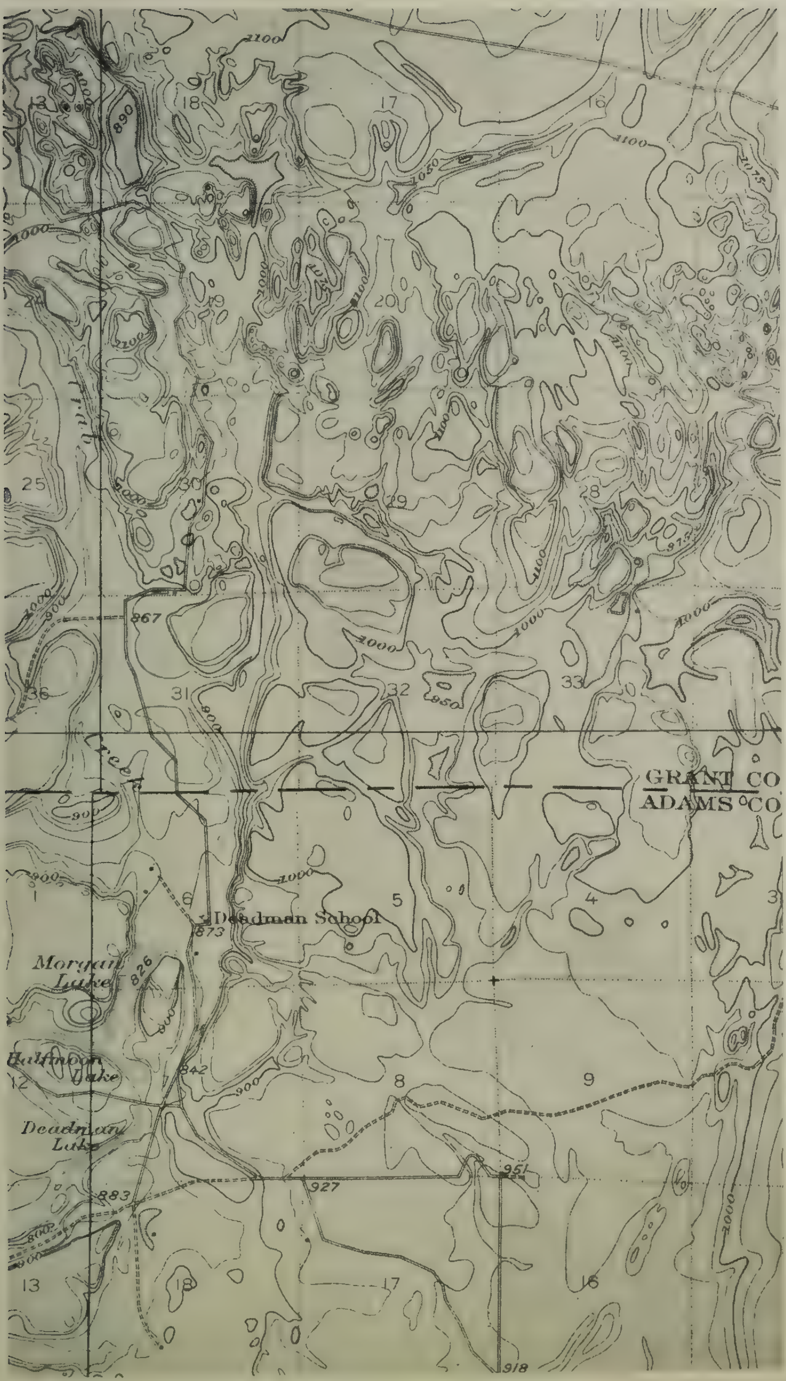


FIG. 21—A part of the Drumheller Channels, the southern spillway from the Quincy Basin. (Reproduced from the Corfu (above) and Othello (page facing) topographic sheets of the U. S. Geological Survey.)



The area shown is slightly less than that of Figures 19 and 20 with which it is to be compared. The scale is one inch to a mile, nearly twice that of Figures 19 and 20. The contour interval is 25 feet.

Widely spaced buttes also occur on broad scabland surfaces which have no other marked relief (Fig. 22). The summits of some of these are higher than the loess-basalt contact in adjacent marginal scarps. They appear to be remnants of pre-loess elevations on the surface of the basalt and are not a record of great erosion by glacial water. But the closely associated buttes and basins have no adequate explanation other than the one proposed.

PLEXUS GROUPS: THE DRUMHELLER CHANNELS

There are a few tracts of scabland where all the erosional features above described exist in a closely related group, in sharp contrast with the adjacent higher preglacial topography. The most marked of these is Drumheller Channels, the southern dischargeway from Quincy Basin (Figs. 19, 20, and 21). This spillway is a labyrinth of abandoned channels and rock basins among buttes, hills, and higher scabland surfaces of the basalt. The maze is eroded across the nose of a plunging anticline in the basalt. Its total width is nine miles, and in a single cross section the total vertical range of the scabland is 375 feet. It is difficult to count the channels because of the anastomosis and the indefiniteness of some of them, but nearly 150 definite channelways can be identified. They range from less than a mile to more than ten miles in length, and their floors are as much as 200 feet below adjacent butte tops. Almost every butte top has channels across it or heading on it, almost every large channel has buttes in it, and in many cases assignment of definite boundaries must be arbitrary. Most of the channels have continuous descending gradients, but there are many whose floors rise in places in what was undoubtedly the downstream direction.

Relations among these channels are instructive. The larger ones can be traced continuously through the maze, but many smaller ones and some large ones flare out downstream and lose their channel character in the generalized scabland. A larger number head in the scabland plexus 200 to 300 feet above the adjacent deeper and continuous channels. Junctions of small channels with the larger ones are but rarely accordant. The numerous small channels are on butte tops or on the higher tracts among the buttes. Their divergence from, or entrance to, the larger channels is almost invariably hanging.

Another remarkable feature of Drumheller Channels plexus is its rock basins. One hundred and eighty-two of these are shown by the 25-foot contour interval of the Corfu and Othello topographic sheets of the U. S. Geological Survey. The larger ones are in the more prominent channels and are elongated with the channel shapes. Many of the smaller ones are on butte tops, unassociated with definite channel forms.

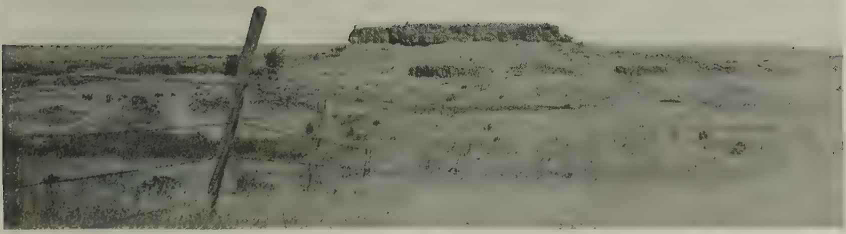


FIG. 22

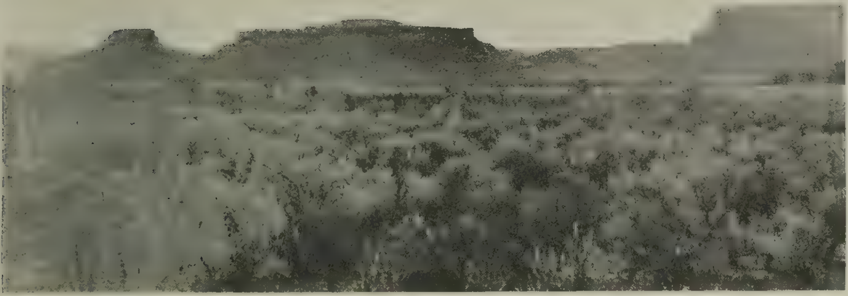


FIG. 23

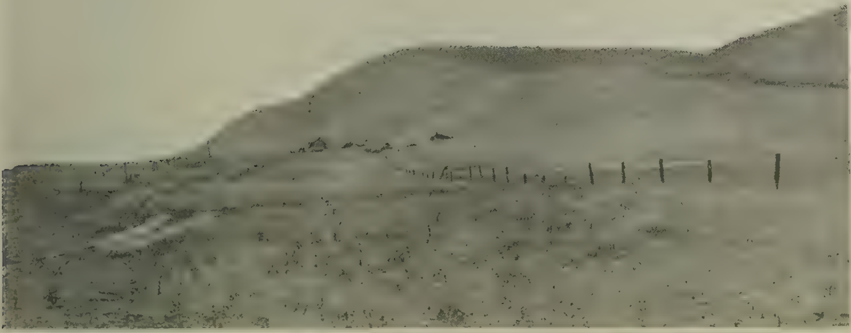


FIG. 24

FIG. 22—A mid-channel butte. Absence of other basalt buttes or ledges at its level indicates that it records a hill of pre-loess topography. (Photograph by L. C. Robinson.)

FIG. 23—Trenched spur buttes in Crab Creek valley near Wilson Creek station.

FIG. 24—Scarp in loess three miles northwest of the mouth of Palouse River. Base of scarp 1320 feet A.T., about 800 feet above Palouse. A valley in the loess left hanging by erosion shows on the right. (Photograph by Donald Bell.)

Drumheller Channels constitutes one of the most peculiar groups of topographic forms to be found anywhere. It suggests karst topography, which it is not. The discontinuity and irregularity slightly resemble those of a morainic region or a tract of dunes. But the field evidence is convincing; the topography is the result of running water. For its development the tract must be covered with a current deep enough and vigorous enough to erode these channels and rock basins where there previously had been nothing remotely resembling them. It is permissible to think that, as erosion progressed, the glacial waters were concentrated in the deeper continuous channels across the ravaged anticline. But the deepest rock basin of the plexus, lying in the east-central portion, is two miles and a half from the nearest of these continuous channels, its rim 150 feet above that channel floor, and its bottom not 25 feet above. The demand for an initial great volume is obvious.

Trenched Spur Buttes and Junction Buttes

The deeper preglacial valleyways entered by the glacial streams possess a type of scabland eminence that closely resembles the mid-channel butte but has a somewhat different genesis. This type, the trenched spur butte (Fig. 23), occurs on the inside of curves of the original valley. The great glacial rivers, filling these valleys to the brim and even overrunning them, could not tolerate the leisurely preglacial curves. The submerged slip-off slopes were the most exposed places in the extemporized channelways and were most vigorously attacked. A common mode of attack was the cutting of a gorge or trench across the slip-off spur. This provided a more direct route and left a scabland butte, the terminal part of the spur, isolated in the widened watercourse. Widening by a method peculiar to this region and this episode is recorded by the buttes of this type. They are not common forms, for they require a particular setting and a particular behavior of the glacial river. They are not limited to the plateau scablands. Snake River Valley possesses two remarkable trenched spur buttes, well shown on the Wallula topographic sheet of the U. S. Geological Survey, and there is an equally remarkable situation involving trenched spur buttes in the Columbia Valley 115 miles by river below the mouth of the Snake.

In a few places where large glacial streams, occupying preëxisting valleys in basalt, joined to become one, the tip of the separating divide was severely eroded and cut into buttes much like a trenched spur series except for situation. The erosion seems to have resulted because one of the confluent rivers had superior volume and a part of it poured across the divide tip into the other valley. The junction of Crab Creek and Coal Creek, a few miles east of Odessa, possesses four such buttes in line.

EROSIONAL FORMS IN OVERLYING SEDIMENTS

The erosional forms of channeled scabland are not limited to the basalt. Bearing their own distinctive characters, they occur in loess and other sediments that overlie the basalt. They may be classified under the terms scarps, relict hills, and channels.

By far the most common form is the scarp, a steepened slope in the overlying formation (Fig. 24). It is almost invariably parallel to a glacial river course, very seldom transverse. It invariably is marginal and almost invariably rises above the highest limit reached by glacial water at that place. It is analogous to the basalt cliffs of the scabland but always occurs at a higher level, its base essentially at the altitude of the highest rugose basalt surfaces.

Scarps commonly truncate the slopes of the mature topography. Their relations to it are like those of sea cliffs to older erosional slopes. Their heights may be as great as 200 feet, their slopes as steep as 35°. Their

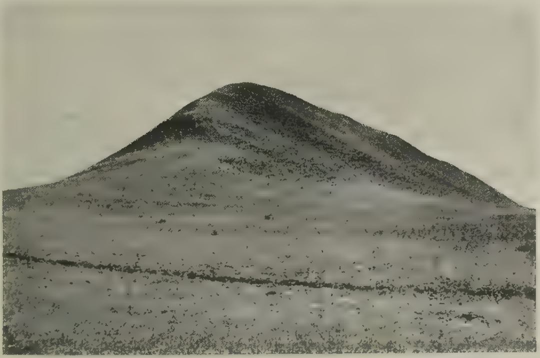


FIG. 25

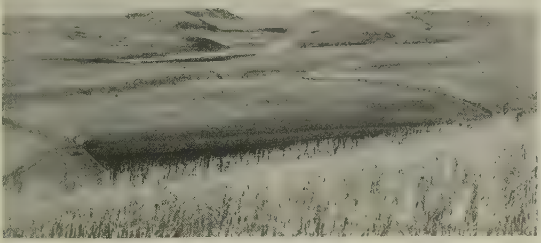


FIG. 26

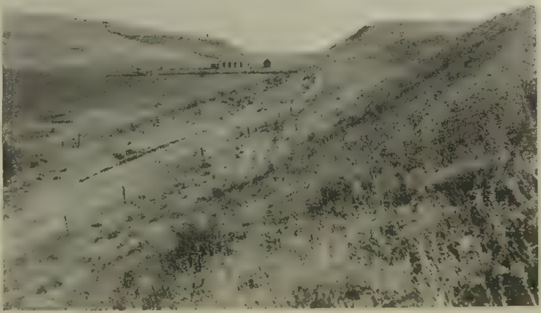


FIG. 27

FIG. 25—Relict hill of loess, 180 feet high, surrounded by scabland. Near Hooper, Wash.

FIG. 26—Cluster of relict hills, remnants of a minor divide. Near Hooper, Wash. The hill shown in Figure 25 is one of this group.

FIG. 27—Channel in loess, looking north into Washtucna Coulee, whose preglacial floor is 350 feet lower. Nunamaker School, southwest of Washtucna, Wash.

alignment along the margins of scabland river routes, their consistent development whether the glacial river was a quarter of a mile wide or twenty miles, their formation in piedmont waste or gravel material, their orientation in various directions, their absence at the summit of loess-capped basalt cliffs in non-scabland valleys, and the occurrence of rock basins, cataract ledges, canyons, and gravel bars close to their bases—all these circumstances debar any other interpretation of them than as integral parts of the scabland system.

The "islands" of loess which make striking features on many broad scabland tracts are almost invariably elongated with the gradient of that tract and are almost invariably scarped on the sides and upgradient end (Fig. 25). Convergence of the lateral scarps to this upgradient end in many cases produces a definite prow, like the conventional pilot of a locomotive. Small "islands" may have their summits determined by the upward convergence of the lateral scarps. Larger ones commonly carry the mature topography that characterizes the loessial mantle east and south of the scabland system. Many such hills or hill groups are separated by narrow scabland channels. Some stand alone in the scabland, miles from any others of their kind. There are more than 350 of them that do not exceed five miles in length. They are commonest in elongated clusters close to the margin of a much larger tract of loess hills (Fig. 26). These clusters record one or more minor divides, the valleys among them having been completely destroyed and the divides themselves narrowed by marginal sapping until cross channels through them appeared. All gradations can be found between a group of channeled valleys in a loessial tract to a group of isolated relict hills with wide scabland separating them.

It is not difficult to see in these island hills the residuals or relicts of a once complete mantle of weaker material. The difficulty lies in explaining them by any other hypothesis. If the glacial waters diverted across the plateau had been in volume comparable to that which made the spillways from Labradorean or Keewatin ice in the northeastern and central states, only a few preglacial valleys would have been demanded to care for the discharge. The fact that two of the four source routes were stripped of their loess (except for a few relict hills) over a width of 20 miles is very significant. It is in harmony with the other phenomena of scabland, all of which call for an extraordinary volume and depth, despite the notable gradients that existed.

Glacial spillways without scabland floors exist in the anastomosis (Fig. 27). All are small features. The divides crossed by the water entering them stood too high and too far from the main routes to allow any great volume. In some of these there is good basalt scabland at the head where the divide was crossed. Most of them have definite margining scarps. Gravel deposits on their floors, typically containing a few foreign cobbles and boulders, are also common. In large part, they are still the preglacial minor valleys, though most of them are clearly set off from adjacent valleys of this category by the features above noted.

Groups of such channels, closely spaced and nearly parallel, cross some of the relict hill areas. They are taken to represent the initial violation of the whole of the vanished loess cover. Where the broad scabland areas now exist, this initial stage was succeeded by deepening and, especially, widening until lateral planation had destroyed many thousands of these hills of the preglacial dendritic pattern.

This conception is not especially difficult to accept if no capacious preglacial valleys existed among them. Such was undoubtedly the case in the northern uncanyoned scabland tracts. But the same groupings of closely spaced channels are found farther south where there clearly were preglacial valleys 300 feet to 400 feet deep in basalt. The same flooding across minor divides to make the minor channels in loess occurred here also, despite the presence of capacious valleys below the upland loessial topography. The need for great volume is nowhere set forth more strikingly.

Depositional Forms of Channeled Scabland

It has been pointed out that all the peculiar features of channeled scabland knit together into a harmonious scheme on the thesis of tremendous volume of the escaping water. Should one, however, argue that the scabland denudation can be explained by assuming smaller streams and allowing more time, he must logically test this interpretation by the deposits of these streams. They afford probably a more crucial test of any hypothesis than do the erosional forms. As befits this paper, only the deposits with definite topographic expression will be considered.

All scabland channels possess discontinuous mounds, hillocks, or hills of stream gravel. Essentially none possess gravel terraces. The mounded deposits may occur in rock basins or perched high on channel walls. In form they are characterized by a rounded crest or summit which is commonly elongated with the channel, an enclosed or partially enclosed fosse between the crest and the adjacent channel or basin wall, and the complete absence or only the incipient stages of gullying (see Fig. 10). They are constructional forms; as definitely so as kames, eskers, cones, or deltas, though differing from all of these.

In situation they commonly lie either on the downgradient side of mid-channel buttes, trenched spur buttes, relict hills, or other eminences in the scablands; or in alcoves and recesses of the channel courses. Not a single prominent non-scabland valley entering the complex is known to be without them at the place of entrance.

In distribution they occur all through the scabland complex, from the summit of the plateau divide near the head of the channel groups to the great gravel deposit at Portland west of the Cascade Range.

In structure they are prevailingly current-bedded. Many of them possess long foreset strata like those of delta fronts, paralleling a steep slope in the mound. Their steep faces, like delta fronts, were growing faces. Débris that was swept over them came to rest in quieter places in the great rivers.

In composition these hills of gravel are dominantly of local material. Many along the Snake and Columbia have 75 to 90 per cent local material, though the present river gravels in close juxtaposition may have this ratio of local and foreign material completely reversed. Some have abundant pebbles, cobbles, and even boulders of loess, of silt, and of soft calcareous material associated with the hard basalt. Many sections show a large percentage of angular decayed basalt, well mingled with fresh "bright" fragments of the same rock. Decay of the deposits as a whole has extended but a foot or two below the surfaces. No differences have been found in amount of decay of the higher and lower deposits.

In magnitude these hills range from low mounds covering an acre or so to huge piles measuring a hundred to four hundred feet from lowest base to crest and covering a square mile or more. A few of them extend through the entire vertical range of scabland in their neighborhood. Their magnitude, both in actual size and in relation to the valleys in which they occur, is the most arresting feature among all their surprising characteristics.

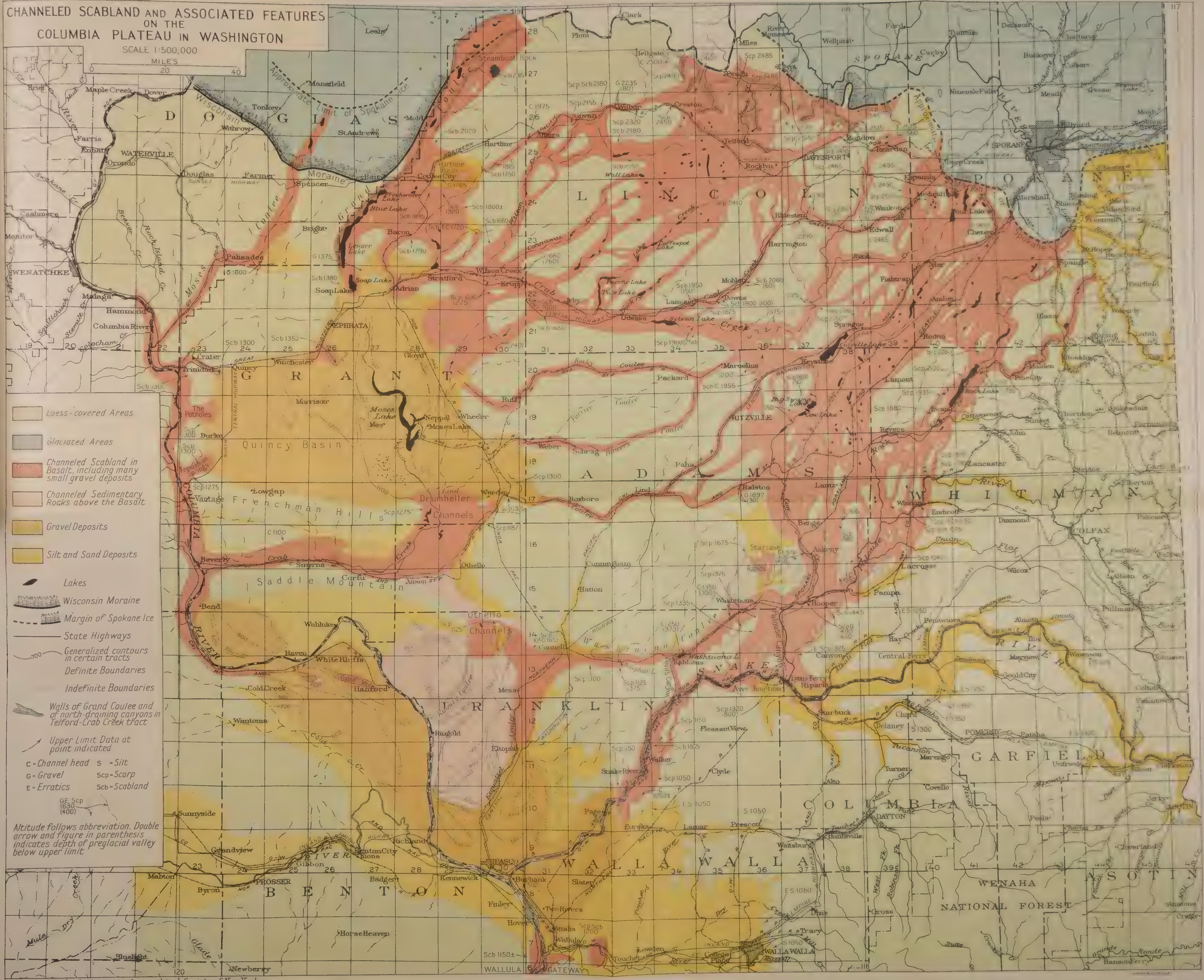
They are unlike any other detrital accumulations except the much smaller features of river channels commonly called bars. With these there is exact parallelism except for size. When considered in their setting in the scabland system, with all its other evidence for great volume and great erosion, they are seen to be an integral part. They should exist! And if they are bars, the great scoured channelways should exist! Again this assemblage of unique land forms in the Pacific Northwest is seen to be a genetic group. A lively imagination is required for the acceptance of the hypothesis, but a scientific imagination withal.

The Causal Episode

It is difficult to convey by words and pictures a visualization of the observable relationships of channeled scabland. Such terms as "canyon," "cataract," "scarp," "gravel deposit," calling up images of the usual topographic forms, suggest the usual explanation, which involves far less water and far more time than the writer's hypothesis demands. Put a glacial Columbia first in one channel, then in another, then in a third, instead of running all of them at the same time; use

CHANNELED SCABLAND AND ASSOCIATED FEATURES ON THE COLUMBIA PLATEAU IN WASHINGTON

SCALE 1:500,000



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more than one glacial episode if necessary; upwarp the transected divides to give the present high altitudes above valley floors. Procedures such as described here are unheard-of. Other ice sheets have come and gone and left no such record. How could such quantities of water be yielded from so small a front and with so little retreat?

It may be that there are other significant facts yet to be discovered. But the writer is convinced that the relations outlined in this paper do exist and that no alternatives yet proposed by others or devised by himself can explain them.

That unique assemblage of remarkable physiographic forms on the Columbia Plateau in Washington, described here as the channeled scabland system or complex, records a unique episode in Pleistocene history. Special causes seem clearly indicated. But what these causes were is yet an unsolved problem.

THE PEOPLE OF THE VEIL: A REVIEW*

E. F. Gautier
University of Algiers

IN 1922 Mr. Francis Rodd undertook an extremely interesting journey to the mountains of Aïr in the central Sahara, occupied by Tuaregs, the Veiled People.[1]

Aïr is a volcanic massif, some of whose summits attain a height of 2000 meters. It lies in the heart of Africa, on the southern border of the Sahara. Our first knowledge of the region comes from Barth, who led an expedition in the service of the British government in 1850. French occupation dates from 1901, the seat of administration being established at Agades in 1904. The region now forms a *cercle* of the Colonie du Niger, the youngest of the French colonies. The colony is administratively attached to French West Africa, whose capital, Dakar, is 3000 kilometers distant in a direct line, without any modern means of communication.

ASPECTS OF AÏR

The country is pacified but still is imperfectly known. In addition to the accounts of the earlier explorers, Barth and Foureau and Lamy, we have the very incomplete maps of Cortier, "Les Touareg du Sud-Est L'Aïr" by Lieutenant Jean (1909), the first French officer in charge, a chapter in Chudeau's "Sahara Soudanais" (1909), Buchanan's "Out of the World North of Nigeria" (1921), and finally Abbadie's "La Colonie du Niger" (1927), published after Mr. Rodd's book had appeared. These constitute almost the entire bibliography.

Aïr is separated from the English frontier by some 300 kilometers of steppe. Mr. Rodd crossed it by the old road through Tagedufat; almost abandoned today, says Colonel Abbadie, for the western road, where the wells are better. He traveled lengthwise of the massif, which is 200 kilometers long and 60 kilometers broad, from Agades to Iferuan. His route is tied up to astronomically determined points, including his own observations. He rediscovered Barth's old camp, Tintellust, which does not appear on the French maps. He makes some interesting suggestions on the wadis of southern and southeastern Aïr. What is least known in Aïr is the network of valleys. Extensive massifs, such as the Bagezan Mountains, remain unexplored. Mr. Rodd explains why. They are practically inaccessible to the camel, the only beast of burden, and porters are not to be enlisted. He describes the Damergu country in exact and vivid terms, noting the pleasure of the traveler who suddenly emerges from the suffocating discomfort of the thorny bush to enter its cultivated fields. Mr. Rodd unfortunately is no physiographer: to find an explanation we must look to Chudeau who points out that the bush flourishes on sandstone (Lower Cretaceous), while the surface of Damergu is covered with clay (Middle Cretaceous), which retains the waters of the rare storms. Other land forms of special interest noted by Mr. Rodd are the Tiggedi cliff, 200 kilometers long, apparently a fault scarp of a type known elsewhere in the Sahara and well preserved under the arid climate; and Mt. Gheshwa, a cinder cone with fresh lava flows. It has long been known that Aïr is volcanic, but so recent a volcano has not, I believe, been pointed out before.

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* Francis Rennell Rodd: People of the Veil, Being an Account of the Habits, Organisation and History of the Wandering Tuareg Tribes which inhabit the Mountains of Air or Asben in the Central Sahara. Macmillan & Co., Ltd., London, 1926.

[1] The journey was made in the company of Angus Buchanan, who had previously visited the area, and T. A. Glover.

Mr. Rodd has lately returned from another journey to Aïr, the results of which are briefly announced in the London *Times* for March 19 and 20.—EDIT. NOTE.

However, it is not so much the country that interests Mr. Rodd as its inhabitants, as the title of his book implies.

The Inhabitants: Tuaregs

Climatically Aïr belongs rather to the Sudan than the Sahara, since it has a season of regular, if scanty rains. As a result the basis of the population is black, Hausa; but the neighboring Sahara has furnished the white aristocracy, the Tuaregs. The massif has two names: Aïr, which is Tuareg; Asben, which is Hausa. It is the Tuareg who interest Mr. Rodd, these "People of the Veil," so named from the most striking feature of their appearance. Mr. Rodd lived the Tuareg life, seeking to make its intimate acquaintance. "They were my very good friends," he says in his conclusion, "and I was very pleased to live with them, for they were very agreeable." This spirit of friendship indeed permeates the book and makes for its attractiveness. Mr. Rodd communicates a sympathetic feeling for the Tuareg to the reader and inspires the like for himself.

To see deeply into a human society one must approach it thus *con amore*. In addition Mr. Rodd brings a spirit of exactitude, even of meticulousness. He does not deform a fact, and he has good sense. On the Tuaregs—their society, political organization, mode of life, implements—he has gathered very complete data, which he presents in a well balanced picture. I do not know where one would find its equivalent, even in French; certainly not in English.

Mr. Rodd has contributed little in the way of new facts, but he makes some interesting suggestions for further research. He notes in passing, "the wild men of Aïr," who live in the Tamgak Mountains. They are "nobles," whites that is, who "speak a language which the Tuareg do not understand." Unfortunately he has to add "I never succeeded in seeing these curious people." Mr. Rodd also mentions the libraries of Aïr. "Most of these precious books . . . were lost when the whole of Aïr north of the Central massifs was cleared by French Camel patrols after the 1917 rebellion." It is one of the many unhappy consequences of the war. Arab books 99 times out of a 100 are a deception for historic research; but assuredly all that can be saved should be saved. There is tempting work for an arabist.

The Problem of Tuareg Origins

Where he is dealing with facts Mr. Rodd is sure; but the Tuareg problem is too intriguing for him not to essay its solution. He builds theories and here is less happy. Furthermore, though Mr. Rodd speaks Arabic and his career in the diplomatic service put him in touch with the Near East he unfortunately does not appear to be acquainted with the Maghreb (French North Africa).

Aïr is a little corner of the Tuareg world which encompasses all the central Sahara. Mr. Rodd sets out from his corner by extensive reading. He plunges bravely into the bibliography of the subject, but it bristles with difficulties. It is very scant and in process of rapid revision. To judge by his silence some important facts seem to have escaped Mr. Rodd. For instance, he does not appear to be aware of the tomb of Tin Hinan,[2] which is dated and which throws a most significant light on the Tuaregs of the Middle Ages. Nor does he appear to be acquainted with the monuments, the so-called "sacrificial circles," which have often been photographed and which certainly are related to a pre-Islamic Saharan religion.

He notes in Aïr, "Early Period" rock drawings, which would be an interesting novelty. But he tells us they are "accompanied by . . . inscriptions" and that they "represent animals which exist," . . . "there was no chiselling or cutting: the lines were made by hammering" . . . "they portray a similar fauna and habit of life to those of today" (pp. 264–265). All these features are contrary to what one knows of "early rock drawings," which represent a fauna vanished, as the elephant, or extinct, as *Buffelus antiquus;* when human figuration appears it has no relation to the present-day peoples; the drawing is never "hammered"; it is always deeply "cut."

The veil is not as exclusively a Tuareg characteristic as Mr. Rodd believes. The Tibbus of Tibesti, who are an entirely different Saharan group, also use it (see Nachtigal). The Tuaregs of Aïr, like those of the Ahaggar, are so exclusively meharists that "dissociation of the Tuareg from his camel is difficult to conceive." And yet there are around Timbuktu, in the bend of the Niger, a group of Tuareg who are strangers to the camel. They are horsemen, pure and simple, a fact which involves a modification of their manner of fighting. They carry two javelins which they can throw from horseback at a gallop with astonishing dexterity. Aside from this the group seems to be similar to the others, at least as far as one knows; for, despite the fact that they are probably more important numerically, they are less well known.

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[2] E. F. Gautier: The Ahaggar: Heart of the Sahara, *Geogr. Rev.*, Vol. 16, 1926, pp. 378–394.

The works studied by Mr. Rodd appear sometimes to have given him difficulties of interpretation. Halévy was in his time an erudite scholar. He sought to explain the Libyan alphabet by the Phoenician, ancestor of the T'ifinagh characters retained in Tuareg usage. But Halévy wrote a half-century ago. Since then the excavations of Evans in Crete have revealed to us a sea aristocracy of the Aegean, preceding that of the Phoenicians; and the clay tablets unearthed by him at Cnossos bear characters whose resemblance to the Libyan and T'ifinagh characters is troublesome. Seeking the etymology of the word "Tuareg," which is the plural form of "Targui," Barth proposed an Arab root which signifies "renegades," and Duveyrier fell in with the suggestion. The Tuaregs assuredly are lukewarm Mohammedans, and the Arabs may justly reproach them in this respect. Barth and Duveyrier are great names in Saharan exploration; but they wrote three-quarters of a century ago. The etymological puns to which the Arabs are prone are today discredited. Furthermore, since the time of Barth and Duveyrier the Arab historian Ibn Khaldun has come into prominence; he reveals to us the existence in the Middle Ages of a Veiled tribe, which he calls Targa, plural Tuareg. The name of this tribe has doubtless been extended to all wearers of the veil. Mr. Rodd appreciates the importance of this great historian. He devotes a long analysis to his work in which, however, I believe he has lost the thread. As he himself observes, "Ibn Kaldun's writings are voluminous and have a baffling tendency to jump about from subject to subject."

Mr. Rodd objects to the use of the name Berber, "which implies a number of wholly imaginary anthropological connections. Moreover it is even open to doubt whether the Tuareg are Berbers at all." He says that the language of the Tuaregs is "one of the languages termed 'Berber,' the only connection in which I am prepared to admit the use of this word." But no one careful of scientific expression employs it in other sense than that accepted by Mr. Rodd himself. "Berber" is applied to a group of tribes pertaining to the white race whose sole bond is community of language; no other definition is possible. And the Tuaregs assuredly belong to this group spread over all North Africa west of Egypt.

The ancients named North Africa Libya and its inhabitants Libyans. The Latinized cities of Roman Africa, in current usage applied the term "barbari," barbarians, to all the natives who had not adopted the Latin tongue. The Arabs arabicized the Latin name. This etymology is not accepted by all scholars, but it is evident enough to those who day by day see French words passing into Arabic or into Berber. The French "bidon" becomes "beidoun," plural "bouadin"; "jugement" becomes "jugmen," plural "djouadjem"; "automobile" becomes "tomobil," plural "timmaboula." It is probable enough that "barbari" became "berberi," plural "Beraber," whence our "Berbers." One thing is certain. After the Arab invasion the word "Libyans" was immediately displaced by "Berbers," which has exactly the same significance.

But too much stress has been laid on these erudite controversies. Mr. Rodd, as we have said, is an admirable observer of concrete facts, and his fundamental good sense reappears in his conclusion to which all can subscribe, if formulated in somewhat different terms.

The Tuaregs are a group of Berber tribes, or, if Mr. Rodd prefers, Berber-speaking peoples. But the group is fundamentally different from the others. Everything—physical build, psychology, social organization, material equipment—puts them in a class apart. They have had a great past, much more brilliant than their present, as Mr. Rodd has sensed. Precisely what their past has been I am not prepared to say. I believe that Mr. Rodd has anticipated certain researches that remain to be undertaken and discoveries that remain to be made.

THE SAHARA IN ANCIENT TIMES

A book by André Berthelot, "L'Afrique Saharienne et Soudanaise: Ce qu'en ont connu les Anciens," just published,[3] is full of interesting suggestions regarding the great problem which has inspired Mr. Rodd. To understand the past history of the Sahara one must go back to the Glacial period. At this time when Europe was mainly covered by ice the great human habitat was in the Sahara, not then a desert, but a steppe traversed by great rivers. And not only the Sahara properly so defined, but also Arabia, the Syrian Desert, and Mesopotamia. All this desert terrain of today may well have played the rôle of refuge, as the botanists say, at the time when Europe to the north was ice-covered. This has a bearing on the detailed facts that have not escaped Mr. Rodd.

In the Sahara is found a magnificent collection of Neolithic tools, perhaps the best in the world. It includes great numbers of enormous primitive millstones for grinding grain. Now the cultivation and utilization of the food grains in the Sahara still exhibits an astonishingly primitive character. Certain grains, for example *Aristida pungens*—the drinn of the Arabs, toulloul of the Tuaregs—are gathered and made into flour as soon as nature furnishes a supply: they are not cultivated at all. Such a proceeding savors of the dawn of cereal agriculture. It is not impossible to conceive of agriculture being born here.

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[3] Les Arts et le Livre, Paris, 1927.

Then came the great catastrophe, desiccation, the more or less slowly progressive invasion of a desertic climate. Agriculture and civilization quickened their evolution in the valleys of the only great rivers surviving—Nile, Tigris, and Euphrates. On the rest of the terrain, henceforth desert, agriculture remained in a state of arrested development, fossilized one might say. Many of the characteristics of Tuareg civilization go back to this period, properly antediluvian.

Much nearer our own time we can clearly see in the history of the Sahara certain great turning points. Probably no one has emphasized so strongly as Berthelot the profound and terrible repercussions of the appearance of firearms in the Sahara and Sudan. Evidently this revolution contributed to the decline and retreat of the Tuaregs. As Mr. Rodd notes, it is a point of honor with them to remain faithful to exclusive use of side arms: a virtue of a necessity, for how could these poor folk buy rifles? But it is in the Sudan especially that the consequences of this revolution have been frightful. Up to the sixteenth century the great negro empires of Ghana, Melle, and Songhai existed on the border of the Sahara and Sudan. They represented a beginning of public order and under them agriculture had flourished, as Mr. Rodd has observed. Their prosperity was abruptly broken towards the middle of the sixteenth century when a Moroccan army took Timbuktu and overturned the Songhai Empire. This little army, which included many Spanish mercenaries, owed its success to firearms—the first seen in the Sudan. From that moment the Sudan entered on a period of ravishment and untold suffering which European colonization has scarcely ended yet and whose consequences are far from being effaced. This was the period of slave trade on a grand scale for foreign markets.

Another great revolutionary event in the history of the Sahara, of earlier date but still within the clear light of history, was the arrival of the camel. It is definitely known that the camel was introduced by the Romans at the end of the Empire, between the time of Septimus Severus and that of Hadrian. It is impossible to imagine the Sahara today without the camel; and yet such must have been the case.

At an epoch still more remote the horse was introduced. The horse unquestionably came from Asia: it appeared in Egypt towards the epoch of the new empire, two millenniums before Christ. Note that the horse as well as the camel is a military beast. The first tribes who had horses had a superior force which they did not hesitate to abuse.

The Sahara as a Human Region

In our customary view of things we see the Sahara solely as a barrier between two different zones. Looked at in the true historical light it is a region itself, with its own history and a history furthermore closely related to our European civilization.

Of this history and its crises the Tuaregs are only a curious survival. They cannot be understood without a comprehension of the human past in the Sahara. Today as the automobile makes this mysterious region accessible one may hope to lift the veil.

One of the most interesting aspects of Mr. Rodd's book is that it is the work of an Englishman treating of a French colony. It sets an excellent example. English or French, the Sudan is the same country. Nigeria and French West Africa have many interests in common. Mr. Rodd believes that the dearly-won victory of some French officers about Agades in 1917 "saved a British colony from facing a situation which might have become serious." This little feat of arms, he says, has "probably never even been heard of, still less recognised, in England."

Mr. Rodd notes the important rôle played by the Tuareg in the caravan trade of Nigeria. On the Niger bend, the old and dead town of Gao, former capital of the Songhai Empire, is taking life again and becoming the center of an important trade in French cattle sold in English Nigeria. In the heart of the Niger bend, the Mossi country is the center of a temporary migration of agricultural laborers who cross the frontier to amass a small peculium in pounds sterling. The government of French West Africa, after a long inquiry into the cotton plant, recommends a species acclimated in Nigeria. The great towns of northern Nigeria—Sokoto, Katsena, Kano—are important as the points whence set out the trans-Saharan routes of Aïr.

And yet these two complementary regions are quite ignorant the one of the other. The political frontier, an artificial matter of treaties, seems to oppose an uncrossable barrier to mutual investigation. I know of but one scientific expedition that has worked impartially in the English as well as the French Sudan, that of the German, Leo Frobenius, who has published his results in the books "Auf dem Wege nach Atlantis" (1911) and "Und Afrika sprach" (1912); and it appears that he found difficulties at times. In the second work he complains of certain English officials, and, unless I am mistaken, these officials on their part have no altogether happy recollection of Frobenius. Mr. Rodd's journey shows that the obstacles are not insurmountable. It is true that he was able to renew a war-time camaraderie with the French officers commanding the military posts, and this naturally contributed to his success. But his personality, which shines through his book, would alone have assured it.

THE ALTITUDE OF ACONCAGUA

Luis Riso Patrón

Chief, Chilean Section, Tacna-Arica Boundary Commission

ARTICLES still appear in print now and then calling attention to what is considered to be the lack of accuracy in the determination thirty years ago of the height of Mt. Aconcagua, the King of the Andes.

It was for this reason that I was persuaded in 1910 to write to M. Victor Huot of the staff of *La Géographie*. In my letter, from which an extract was published in *La Géographie* of August 15, 1910, I explained the method by which we determined the height of 6960 meters as adopted on the Aconcagua sheet of the series of maps of the Chile-Argentine Boundary surveyed by the Chilean Boundary Commission and published by the Oficina de Límites of Chile. The method had already been explained in my book "La Cordillera de los Andes entre 30° 40′ i 35° S. (1903)." In 1925 a question concerning the "exact" height of Aconcagua was addressed to me from Washington, the information not having been found in my "Diccionario Jeográfico de Chile" (Santiago, 1924) because Aconcagua is on the Argentine side of the Cordillera. Dr. Robert Helbling, in his "Beiträge zur topographischen Erschliessung der Cordilleras de los Andes zwischen Aconcagua und Tupungato" (Zurich, 1919), stated that the geographical position of Aconcagua was still uncertain and that it was still doubtful whether it was the highest peak in the Americas. In referring to the work of the Chilean Boundary Commission, Dr. Helbling stated that our methods of survey were directed by the Argentine Commission. I wish to say that the methods and procedure of the two commissions were completely independent of each other.

In order to establish the accuracy of the determination of the altitude of Aconcagua by the Chilean Boundary Commission and to substantiate my assertion that Aconcagua is the true King of the Andes, it may be of interest to summarize the methods by which the determination was made.

Methods of Determination

In "La Cordillera de los Andes entre 30° 40′ i 35° S." it is clearly explained that we took as initial control for our Andean trigonometrical operations the positions of well fixed points at Illapel (lat. 31° 38′ S., long. 71° 11′ 3″ W.), San Felipe (lat. 32° 44′ 56″ S., long. 70°

43′ 42″ W.), and Santiago (lat. 33° 26′ 42″ S., long. 70° 41′ 34.5″ W.). By a system of precise traverses we entered the Cordillera, developed our traverse network therein, and finally closed on the starting points with the precision at which we had aimed. I have shown in my book that the errors of closure were satisfactorily small. The map on which have been plotted the trigonometrical operations (scale 1:250,000) between latitude 32° and 35° S. also shows that the intersection of Aconcagua was very good and that no large errors in regard to its position are to be feared. We also have demonstrated that in connection with the heights our trigonometrical work was sufficiently precise.[1]

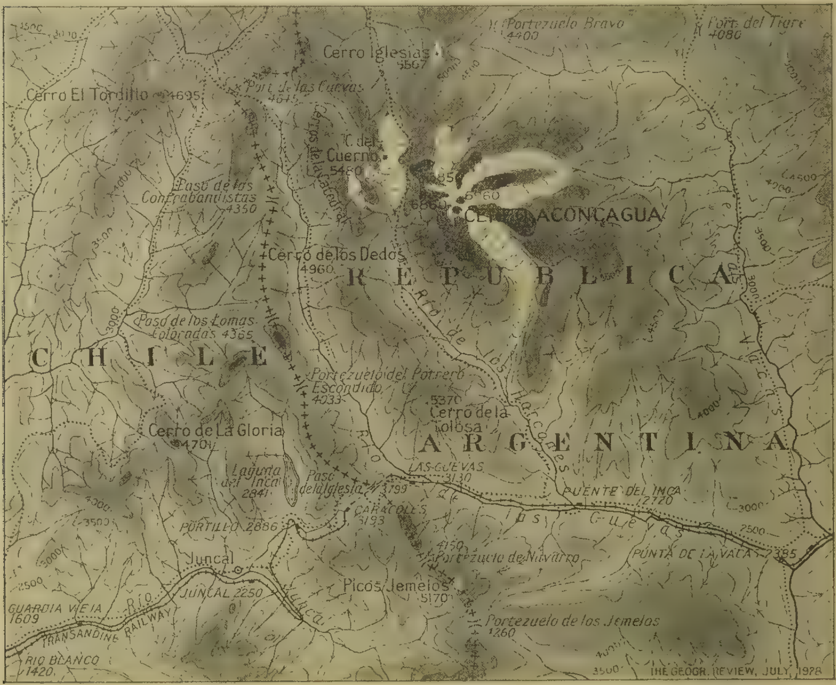

FIG. 1—Cerro Aconcagua and vicinity (scale 1:000,000) from the Santiago-Mendoza sheet of the American Geographical Society's Millionth Map of Hispanic America. This section of the Society's map is compiled from the Aconcagua sheet of the boundary surveys published by the Comisión Chilena de Límites and the surveys for the Transandine Railway.

We obtained our datum level from the railroad in Illapel. We then proceeded up into the mountains and eventually returned to the San Felipe pillar (lat. 32° 49′ 53″ S., long. 70° 36′ 5″ W.). The traverse stations were on the average about four kilometers apart, and when this part of the traverse was adjusted the correction for height per station was only 0.03 meter. From San Felipe we entered the Andes again, proceeded southwards, and terminated our traverse at the top of the little hill Santa Lucia in the center of the city of Santiago. On this latter half of the traverse the height correction per station was 0.26 meter.

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[1] A technical description of the surveying operations of the Chilean Boundary Commission is to be found in Volume 16 of the *Geographical Journal* (1900), pp. 329–345. The author of the paper, Professor A. Bertrand, devised for use on these surveys a precise and ingenious procedure for determining the distances between the traverse stations.

Aconcagua belongs to the Illapel-San Felipe network; and, as the former was intersected before eight traverse stations had been occupied, it seems probable that the altitudes of the stations used in determining the height of the mountain peak are at most only a few meters in error. In addition our traverse control connected with the Punta de Vacas railroad station in the Argentine Republic, and there our trigonometrical leveling was again verified.

The height of the instrument was never taken into account, as we only found it necessary to observe vertical angles to the nearest minute (at a distance of 35.25 kilometers one minute subtends 10.2 meters).

OTHER DETERMINATIONS

A good many attempts have been made to fix the height of Aconcagua. Pissis calculated it as 6797 meters in 1852 and as 6835 meters in 1858 and 1875 from a large triangulation not well checked. Güssfeldt,[2] starting from a base whose height (4098.6 meters) had been determined by means of a single mercurial barometer, computed three altitudes corresponding to the three principal peaks of the summit:

Highest point on the northeast side	6970 meters
Center	6851 meters
Southeast peak	6894 meters

Fitzgerald,[3] in 1897, determined the altitude as 7073 meters, and the Argentine Boundary Commission, in 1898, determined it to be 7130 meters. I have found that Fitzgerald's determinations and those of the Argentine Boundary Commission are all too high in this section of the Cordillera. Moreover, as Dr. Helbling remarks in the book quoted above, neither has given any details as to how their altitudes were determined.

Schrader,[4] in 1904, made a very careful determination of the altitude of the mountain. While carrying out the surveys for the Transandine Railway under commission from the Argentine government, he was able to make several observations from two points whose altitude had been determined with respect to the altitude of the railway station at Las Cuevas (3151.3 meters). He computed the altitude at 6953 meters.

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[2] Paul Güssfeldt: Reise in den Andes, Berlin, 1888.

[3] E. A. Fitzgerald: The Highest Andes, London, 1899.

[4] *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], 1907.

If we reject the results obtained by Fitzgerald and by the Argentine Boundary Commission, it will be seen that the determinations made by Güssfeldt, Schrader, and myself are in very close agreement.

Güssfeldt	6970 meters (22,867 feet)
Schrader	6953 meters (22,811 feet)
Riso Patrón	6960 meters (22,834 feet)

I believe it to be well established, therefore, that the height of the mountain is between 6950 and 7000 meters (22,800 and 22,900 feet), which is sufficient to fix it as the highest mountain in the western hemisphere. It is followed in order of magnitude by:

	Approximate Latitude	Height
Ojos del Salado	27° 7′ S.	6870 meters
Huascaran	9° 4′ S.	6763 "
Tocorpuri	22° 26′ S.	6755 "
Llullaillaco	24° 43′ S.	6750 "
Mercedario	31° 59′ S.	6670 "
Tres Cruces	27° 4′ S.	6620 "
Sorata (Illampu)	15° 50′ S.	6550 "
Tupungato	33° 22′ S.	6550 "

Mt. McKinley, considered to be the highest peak in North America, with an altitude of about 6182 meters falls far short of these peaks.

It is of interest to note that the Swiss guide Zurbriggen of the Fitzgerald expedition was the first man to climb to the top of the mountain. He made his ascent on January 11, 1897, and was followed on February 13 of the same year by Vines and Lanti of the same expedition. Sir Martin Conway[5] and his guide Maquignaz failed in an attempted ascent in the following year. Messrs. Ryan, Macdonald, and Cochrane, accompanied by the muleteer Carlos Lobas, climbed to the summit in 1925.[6] Perhaps the most audacious effort to climb the mountain was that made in the summer of 1926 by Mr. Cornelius Van Engert, Chargé d'Affaires of the United States Embassy at Santiago. He left his mules and guides at an elevation of about 6000 meters, and in the two days following climbed alone in the direction of the highest peak. He had the misfortune to mistake the way on the first day and on the second was forced by a snowstorm to abandon the attempt at about 500 meters below the peak.

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[5] Martin Conway: Aconcagua and Tierra del Fuego, London, 1902.

[6] Ascent of Aconcagua, *Geogr. Journ.*, Vol. 66, 1925, pp. 44–46.

CAPTAIN WILKINS' ARCTIC EXPEDITIONS, 1926–1928

A SUMMARY STATEMENT*

Svalbard Radio April 21

Amer. Geogr. Soc. of N. Y.
Broadway and 156 St., N. Y.

Traversed course outlined. One stop account bad weather. Arrived twenty and half hours flying time. Five days Barrow. No foxes seen. Wilkins.

THUS summarily Captain Wilkins informed the American Geographical Society, the scientific sponsor of his arctic expeditions of 1926–1928, of their successful culmination.

The course traversed from Barrow to Spitsbergen, the first to be made over the Arctic Basin from Alaska, was that planned as being most likely to lead to discovery of land. "No foxes seen" means "no land found," in the language of the code previously agreed on to permit the Society to make the first announcement regarding this feature of the expedition.

The flight was a justification of Wilkins' faith in the airplane as an instrument for polar exploration. "Long-distance flying in the Arctic is not more hazardous than long-distance flying in other regions," he says as a preface to "Polar Exploration by Airplane," his contribution to the Society's publication "Problems of Polar Research."[1] Wilkins' faith, however, was based on long experience. This paper to which we have referred, eminently practical as it is, inspires confidence. Captain Wilkins has had experience both in aviation and in polar exploration. As second in command of Stefansson's party on the Canadian Arctic Expedition of 1913–1918 he made intimate acquaintance with the nature of Arctic ice, an acquaintanceship that on the recent expeditions has stood him in excellent stead. He was second in command of the British Imperial Antarctic Expedition, 1920–1921, and naturalist on Shackleton's last expedition, 1921–1922. The Antarctic experiences confirmed in him the desire to prosecute in particular one phase of polar exploration, the reconnaissance study of meteorological conditions with a view to practical applications, notably in relation to the forecasting of Australian

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*Captain Wilkins' own account will appear in the October number of the *Geographical Review.*

[1] Problems of Polar Research: A Series of Papers by Thirty-One Authors, *Amer. Geogr. Soc. Special Publ. No. 7,* 1928.

weather. As he says in the introduction to his report of the Detroit-Arctic Expedition of 1926: "The science of meteorological forecast has been through the ages one of the most absorbing occupations of humanity, and its possibilities, the prevention of suffering from unexpected droughts and subsequent famine, are humane in the extreme, and its economic advantage, enormous. . . . It has long been my desire to foster the development of polar meteorology by making it possible to carry out a series of prolonged investigations in polar regions."[2] The Arctic expedition of 1926 was planned "as a preliminary to a longer expedition to the Antarctic in the region between King Edward VII Land and Graham Land," as announced by the Society in 1926.[3]

In addition to the meteorological data and the knowledge to be gained of aviation under polar conditions the Arctic expeditions had another objective of their own—exploration of the unknown areas, which at the beginning of 1926 covered some million square miles. The main achievement of the 1926 expedition was, however, accomplished on the Alaskan mainland.

THE EXPEDITION OF 1926[4]

Barrow was selected as headquarters because of its relation to the unknown areas. Plans had been formulated too late to permit supplies to be taken in by boat the preceding summer. It was necessary to convey them overland. An experiment in the use of snow motors proved unsuccessful under the condition of deep, soft, powdery snow obtaining in the Alaskan interior. A dog team took 63 days to reach Barrow from Fairbanks with much loss and hardship. On the other hand the airplane proved highly successful; altogether over 6000 miles of flying were done within the polar circle, most of it over unknown territory. With deviations on account of weather a compass route was flown from Fairbanks to Barrow across the divide between the Arctic and Pacific Oceans—the Brooks Range—named in honor of the late Dr. A. H. Brooks.[5] In the Endicott Mountains section Wilkins describes peaks as attaining 10,000 feet.[6] "It was quite difficult from observations to be sure which valleys were which and because snow patches often resemble lakes and many lakes were hidden in the land with a common blanket of snow.

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[2] Manuscript report in the files of the American Geographical Society.

[3] Captain Wilkins' Arctic Expedition, *Geogr. Rev.*, Vol. 16, 1926, p. 149.

[4] This expedition was known as the "Detroit Arctic Expedition" from the financial support given by citizens of Detroit, especially by the Detroit Aviation Club.

[5] See Philip S. Smith: Explorations in Northwestern Alaska, *Geogr. Rev.*, Vol. 15, 1925, pp. 237–254. Dr. Smith's party crossed the range farther to the west. He describes it as "at least 150 miles wide; its higher peaks rise to elevations of 8000 feet or more, and its crest averages 5000 to 6000 feet above the sea."

[6] Striking photographs of the Brooks Range taken by Captain Wilkins appear in "The Geography of the Polar Regions," *Amer. Geogr. Soc. Special Publ. No. 8*, 1928, p. 193.

There were many more lakes and rivers than marked on the chart, and this made map reading very difficult and confusing. However, we were flying the compass course and gradually gained height until 10,000 feet was registered on the altimeter. Even then we seemed just above the highest peaks which according to our maps were only 5000 feet high."

Four return trips were made across the ranges from Fairbanks to Barrow and back, and on one of the outward journeys flight was continued 100 miles within the unknown area of the Arctic Sea north of Barrow. The flights made by Captain Wilkins with Lieutenant Eielson as pilot well merit the encomium of Byrd and Stefansson as "one of the most heroic and dramatic adventures of polar history."[7]

The Expedition of 1927[8]

The voyage of the *Norge* had rendered doubtful the existence of land along the meridian from Point Barrow to the pole. Captain Wilkins' plans for 1927 therefore called for exploration in the unknown segments northwest and northeast of Barrow. When all was ready for the take-off weather conditions favored an attempt to the northwest into the tract between the route of the *Norge* and the drift of the *Jeannette*, into which it was planned to fly to latitude 78°, longitude 180°. The results have been briefly described in the *Geographical Review*.[9] Wilkins flew 450 miles before being forced down at a position estimated at latitude 77° 45′ N., longitude 175° W. Bad weather was encountered on the return, and the plane ran short of gasoline about latitude 72° 15′ N., longitude 160° W. Wilkins and Eielson first drifted on the ice and then walked over the ice to shore. Two perfect landings on the sea ice proved Wilkins' contention that such a procedure was possible.

The chief accomplishment of the flight was the determination of the ocean depth at the farthest point reached. The preliminary figure was given as 5625 meters. A more refined calculation is now available. In view of the importance of the sounding, the deepest so far recorded in the Arctic, it may be well to describe briefly the method of calculation. Two determinations by the sonic depth finder gave time intervals between detonation and echo of 7.3 and 7.25 seconds respectively. The rate at which sound travels in sea water varies with variations in temperature, salinity, and depth. A recent publication by the U. S. Coast and Geodetic Survey[10] includes a table giving the velocity for every two degrees centigrade and for every thousandth of salinity in each 200-fathom layer of water. Taking 0° C. and a salinity of 35 per thousand as the values in the table nearest to those observed by Nansen in the bulk of the deep water of the Arctic Sea (cf. *inter alia* "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, p. 11), we get a depth of 5458 meters for the 7.3 seconds reading and one of 5419 meters for the 7.25 seconds readings. Taking the mean of these two and adding 2 meters for the depth of the apparatus below the under surface of the ice as reported by Wilkins, there results the value of 5440 meters.[11] This, then, is probably as closely correct a value as it is possible to obtain within the limitations imposed, and it is therefore herewith put forward as the definitive figure for Wilkins' sounding. It has thus been entered on the latest revised edition of Nansen's bathymetric map of the Arctic Basin (*op. cit.*, Pl. I).

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[7] R. E. Byrd and Vilhjalmur Stefansson: The Arctic Flying of Captain Wilkins and Lieutenant Eielson, *Science*, No. 1691, Vol. 65, 1927, May 27, pp. 523–525; reference on p. 523.

[8] This expedition is known as the "Detroit News-Wilkins Expedition," from the backing given by the *Detroit News*. The complete report of the expedition is in the files of the American Geographical Society. An extract was published in the *Geogr. Journ.*, Vol. 71, 1928, pp. 160–166.

[9] *Geogr. Rev.*, Vol. 17, 1927, pp. 497–498.

[10] N. H. Heck and J. H. Service: Velocity of Sound in Sea Water, *U. S. Coast and Geodetic Survey Special Publ. No. 108*, Washington, 1924.

Later another flight was made in the direction of Grant Land. Two hundred miles out, however, fog compelled return, and the lateness of the season prohibited further attempts.

THE EXPEDITION OF 1928

The northeastward flight thus became the first objective of the 1928 expedition.[12] It began at Point Barrow on April 15 at 10 a. m. after a week's delay due to difficulties in take-off with the heavily loaded plane. The route was planned to pass through quite unexplored territory for most of the way and also along a critical portion of the border of the continental shelf as represented upon the bathymetric map by Dr. Fridtjof Nansen in "Problems of Polar Research." The course was set in a direct line to latitude 84° N., longitude 75° W., i. e. to a point north of Grant Land. With the exception of a stretch of some hundred miles between latitude 78° and 80° clear weather permitted close observation of the ground. No indications of land were seen. As regards that region immediately west of Grant Land where the hypothetical Crocker Land was supposed to lie, the despatches report "no sign of islands, leads of open water, ice generally rough and ridged but not heavily pressed as to suggest shallow-water conditions."

At the 84th parallel the plane was headed south until the northern extremity of Grant Land was sighted, 13 hours out from Barrow. Here Wilkins forecast a storm over Spitsbergen and considered the possibility of landing at Cape Columbia, whence, if the flight could not be resumed, way could be made through a "hunter's paradise" to the Royal Canadian Mounted Police post at Bache Peninsula. However, he decided to continue and set the course to Spitsbergen, sighted seven hours later. The predicted storm forced a landing on the northwestern extremity of Ice Fiord, Dödmandsören. After being storm-bound for five days, the flight was resumed and a landing made at Green Harbor on the southern side of Ice Fiord. Here is situated the Norwegian Government's wireless station, and near by is the plant of a Dutch coal-mining concession.[13] The general situation of the station is well shown in the topographic map of the concession in the atlas (Oslo, 1927) accompanying the "Report of the Svalbard Commissioner Concerning the Claims to Land in Svalbard" (Copenhagen, 1927), the maps having been constructed under the direction of Dr. Adolf Hoel.

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[11] Confirmation of the general correctness of this figure is afforded by Table I in "Tables of the Velocity of Sound in Pure Water and Sea Water for use in Echo-Sounding and Sound-Ranging," Hydrographic Department of the Admiralty, London, 1927.

[12] Captain Wilkins organized his third expedition by the sale of some of his equipment of earlier years, supplemented by moderate contributions from individuals and a contribution from the American Geographical Society.

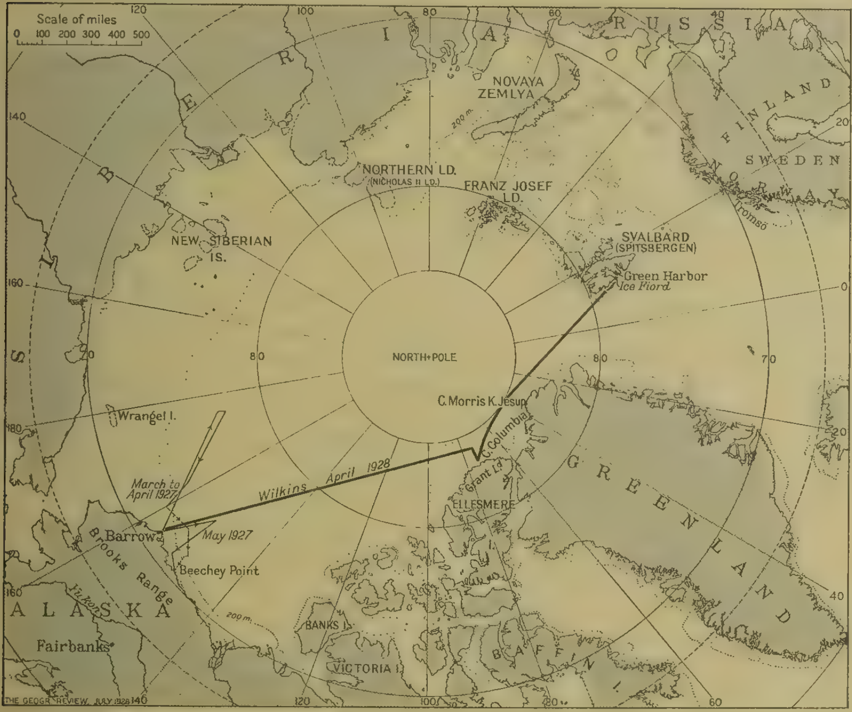

FIG. 1—Map to illustrate Captain Wilkins' flights over the Arctic Basin in 1927 and 1928. Scale 1:50,000,000. The base and the 200-meter bathymetric contour are reduced from Dr. Nansen's "Bathymetric Map of the Arctic Basin" (scale 1:20,000,000) in "Problems of Polar Research," Plate 1, facing p. 14.

One of the outstanding achievements of the flight is the skill shown by Captain Wilkins in navigation. Cutting the meridians obliquely meant greatly increasing the problems of navigation and the risk of getting off his course. He comments particularly upon the accuracy of the navigational chart prepared especially for him by the American Geographical Society. The despatches received show that an exceptionally interesting record of ice and weather conditions has been kept, and the detailed description will be awaited with interest.

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[13] See Adolf Hoel: The Coal Deposits and Coal Mining of Svalbard (Spitsbergen and Bear Island), *Resultater av de Norske Statsunderstøttede Spitsbergenekspeditioner*, Vol. 1, No. 6, Oslo, 1925. The report includes photographs of Green Harbor: other striking aerial photographs are to be found in Walter Mittelholzer: Im Flugzeug dem Nordpol entgegen, Zurich, 1924.

In recognition of his achievement Captain Wilkins has been awarded the Samuel Finley Breese Morse Gold Medal of the American Geographical Society (see frontispiece), of which he will be the first recipient. Announcement of the award is made on page 496 of this number of the *Review.*

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April. At the regular monthly meeting of the Society held at the Engineering Societies' Building, 29 West 39th Street, on March 20, President John H. Finley presiding, Dr. Francis W. Pennell, Curator of Plants of the Academy of Natural Sciences of Philadelphia, gave an illustrated address on "The Andes of Colombia."

At the regular monthly meeting of the Society held at the Engineering Societies' Building, 29 West 39th Street, on April 24, President John H. Finley presiding, Mr. Charles R. Crane spoke on "Moslem Culture in the Yemen and the Hejaz." Mr. Crane, who has traveled extensively in the Near East, in 1926–1927 visited the Red Sea ports. At Jiddah he had an opportunity for first-hand study of the Wahabite movement. He had several interviews with the Emir Feisal, son of Ibn Saud, and he was able to make comparison with the domestic and foreign problems of that ruler and those of the Imam of Yemen whose domain he next visited. The fertile Yemen with its "wonderful terraced valleys where coffee is grown and where the art of agriculture has been developed to a high degree" presents marked contrast to the barren Hejaz. By nature it is extremely isolated, and the policy of the Imam is to preserve that isolation; for his country occupies a highly strategic situation. Mr. Crane entered the Yemen by Hodeida and took up his residence at Sana, the capital on the plateau, where he met "the principal architects, the principal merchants, the military men, and especially the learned men." On leaving Sana he followed one of the ancient caravan routes to Aden.

Special May Meeting of the Society for an Address by Dr. Nansen. A special meeting of the Society was held at the Engineering Societies' Building, 29 West 39th Street, on May 14, when Dr. Fridtjof Nansen delivered a lecture on the "Problems of Arctic Exploration." President John H. Finley presided and in introducing Dr. Nansen referred to his visit of more than thirty years ago. It was at the October meeting of the Society in 1897 that Dr. Nansen received the Cullum Geographical Medal of the Society for his immortal voyage on the *Fram*. In the intervening time much has happened in the Arctic. As Dr. Nansen pointed out in the beginning of his address, the pioneer work of exploration is well on the way to completion, thanks to new methods of exploration. After paying tribute to Captain Wilkins' remarkable flight from Alaska to Spitsbergen, Dr. Nansen discussed the contrast between the new and old methods of Arctic exploration, illustrating with lantern slides and graphic descriptions from the experiences of the *Fram* in 1893–1896. Exploration by airplane is essentially reconnaissance in nature: it must be followed by intensive work done for the most part on the surface, though it may be possible to execute depth soundings from an airship. Among the problems waiting solution Dr. Nansen referred particularly to the determination of the depth and contour of the Arctic Basin; the biology of the North Polar Sea, where interior desertic conditions contrast with luxuriant life on the fringes; the vast importance of the collection of meteorological data; and that little-known phenomenon on which important work has just begun, the aurora. In conclusion Dr. Nansen briefly outlined his own plans for exploration by dirigible in 1929, under the auspices of the International Association for the Exploration of the Arctic by Airship (Aero-Arctic), of which he is president.

Elections to Fellowship. At the March and April meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 25 candidates, who were duly elected as Fellows of the Society.

Award of the Samuel Finley Breese Morse Medal to Captain George Hubert Wilkins. At a special meeting of the Council on April 24, the Samuel Finley Breese Morse Gold Medal of the Society was awarded to Captain George Hubert Wilkins in recognition of his Arctic explorations during the past three field seasons. Captain Wilkins' expeditions are briefly described in an article published in this issue of the *Geographical Review*, and the scientific results will appear in a later issue. Announcement of the award was made at a general meeting of the Council and Fellows of the Society on April 24.

The Samuel Finley Breese Morse Medal fund was founded in 1902 by the will of Samuel Finley Breese Morse, the inventor of the telegraph, who died in 1872 (see *Journ. Amer. Geogr. Soc. of New York*, Vol. 4, 1872, p. 52, and *Bull. Amer. Geogr. Soc.*, Vol. 35, 1903, p. 112). In 1926 the fund had reached a size which permitted the Society to devise a medal—the design is by Mrs. Laura Gardin Fraser—and prepare the dies. It is proposed to award the medal every five years for exceptionally distinguished work in geographical research. Photographs of the medal, obverse and reverse, five-eighths the actual size, appear as a frontispiece to this number of the *Geographical Review*. Captain Wilkins is the first recipient of the medal.

Resolution on the Death of Mr. James B. Ford. The following resolution was passed by the Council of the Society at its meeting of April 19.

"James B. Ford, our Vice-President, died on March 29. It is difficult adequately to express the loss thereby sustained by the Society.

"He gave unsparingly of his time in following and assisting in all the varied work of the administration, with an appreciation that lent enthusiasm to all the staff. His benefactions embraced the support of every undertaking by the Society. Thus he provided funds for the prosecution of the great work of mapping the whole of the Central and South American states to conform to the universal standard of one-millionth—an enterprise without precedent for a private institution. The extensive research work, monographs, and collaboration with governmental and other scientific bodies was rendered possible by him; and his private charity relieved illness and misfortune amongst members of the staff when brought to his attention. His bearing was retiring and unemotional, but his nature seemed to respond to personal contact with worthy endeavor or with human suffering.

"The Council desires to record not only the great benefits received by the Society but also to pay its tribute to an individual character of marked distinction and originality. The impress of his long and intimate relation will never be effaced."

Elections to Membership in the Council. At the meeting of the Council of the Society held on April 19 Mr. Charles R. Crane and Dr. Wesley C. Mitchell were elected Councilors of the Class of 1931.

The Death of Mr. Chandler Robbins. Mr. Chandler Robbins, who was elected a Fellow of the Society in 1872, died at his residence in New York on April 25, 1928. Mr. Robbins held several offices during the period of his connection with the Society. He became a Councilor in 1882 and Domestic Corresponding Secretary in 1897. From 1907 to 1913 he was Chairman of the Council, retiring from that body in 1915.

The Death of Mr. Cyrus C. Adams. Mr. Cyrus C. Adams, former editor of the *Bulletin of the American Geographical Society*, died at his home in Queens Borough, New York City, on April 4, 1928, in his eightieth year. Mr. Adams became connected with the Society in 1902 as associate editor, succeeding to the editorship after the death of Mr. G. C. Hurlbut on December 26, 1908, and holding this position until his retirement in 1915.

Mr. Adams' particular interest lay in the dissemination of geographical knowledge. "The cause of popular geography may be pleaded with earnestness and with dignity by the highest authorities in our study," he said in his presidential address before the Association of American Geographers in 1906 ("Some Phases of Future Geographical Work in America," *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 1–12). Long before his association with the Society Mr. Adams had been a keen follower of the progress of geographical discovery and of its applications; while his newspaper experience—he was for many years an editorial writer on the New York *Sun*—was a notable aid to the presentation of his geographical studies. The increase of size in the *Bulletin* under his direction is a reflection of his flair for geographical news. His textbooks, "A Textbook of Commercial Geography" and "An Elementary Commercial Geography," first published in 1901 and 1902 respectively, are distinguished by the use of "instructive" facts as compared with the generalities in vogue in the textbooks of the time. Another instance of his appreciation of the actual fact is his account of "Lieutenant Peary's Arctic Work" in the *Geographical Journal* for 1893. He had access to Peary's notebooks, and much geographical detail in the account of this work in Greenland has not been published elsewhere.

With Mr. Adams' tastes and opportunities it was natural that he should find special interest in African exploration and geography. Many of his magazine articles were on African topics: "Foundations of Economic Progress in Tropical Africa" in the *Bulletin of the American Geographical Society* for 1911 may be instanced.

Mr. Adams was a tireless advocate of the use of good maps for the advancement of geographical education. He wrote and spoke on the subject (see, for instance, "Maps and Map-making," *Bull. Amer. Geogr. Soc.*, Vol. 44, 1912, pp. 194–201) and gave practical exposition of his ideas. He created a department of "New Maps" in the *Bulletin*, of particular value at the time. He was responsible for the organization of an exhibit of foreign map material which, loaned to universities and schools, traveled across the country from Atlantic to Pacific and had a marked influence on the teaching of geography. A step in the campaign for better maps was the production by the Society of a map of the Catskill Mountains on a scale of 1:190,080, printed in color and published in the *Bulletin* for 1907 (opp. p. 256), "to show our people what a fine atlas sheet, even on a small scale, may be made with topographic sheets of our Geological Survey as a basis." Probably this was the first time that the United States topographic sheets were used for such a purpose.

Mr. Adams was a member of the Association of American Geographers since its foundation, being elected to its council at the organization meeting in 1904. He was also a member of the Washington Academy of Sciences and of the National Institute of Social Sciences.

Recent Publications

The Middle Euphrates: A Topographical Itinerary. Palmyrena: a Topographical Itinerary. These volumes, by Professor Alois Musil, constitute Numbers 3 and 4 respectively of the Society's series *Oriental Explorations and Studies* (see *Geogr. Rev.*, Vol. 15, p. 297; Vol. 17, pp. 145, 178; Vol. 18, p. 144).

"The Middle Euphrates" deals with two expeditions carried out in 1912 and 1915 along both banks of the Euphrates between the great eastward bend of that river and the site of Babylon, as well as in the interior of Mesopotamia. The appendixes contain critical discussions of the probable routes of Xenophon and of Julian the Apostate, reconstructions of medieval trade routes between Baghdad, Kufa, and Syria, an elaborate study of the canals of Babylonia in antiquity and during the Middle Ages, and an examination of the campaign of the Moslem general Khaled ibn al-Walid in the country lying west of the Euphrates.

In "Palmyrena" journeys of 1908, 1912, and 1915 in the territory north and west of the ancient desert city of Palmyra are narrated. The appendixes contain material on the civil and ecclesiastical administration of this region in the early Christian centuries, on Roman and Arabic routes and stations in Palmyrena, and on the country residences of the Omayyad caliphs. The great ruined and deserted town of Resafa is described in detail and illustrated with sixty-four photographs and drawings.

Map of Southern Mesopotamia 1:1,000,000. This map, printed in black and brown, embodies the results of Professor Alois Musil's explorations of 1912 and 1915 between the Euphrates and the Tigris, as described in his volume "The Middle Euphrates" (see preceding note). The map was compiled in much the same manner as the maps of Northern Arabia and the Northern Hegaz, published by the Society (see *Geogr. Rev.*, Vol. 18, 1928, p. 145).

The Coral Reef Problem. This monograph, giving the results of Professor Davis' matured judgment on the coral reef problem, is based on field work in the Pacific in 1914 with supplementary studies in the Caribbean in 1923 and on an analysis of the very extensive literature of the subject. Professor Davis' main conclusion is that "Darwin's theory of upgrowing reefs on intermittently subsiding foundations, extended by introducing the effects of Glacial changes of sea level and temperature, as proposed by Daly, and by adding such minor modifications as may be called for in special cases, will deservedly regain in the present century the general acceptance which it enjoyed through the middle of the past century."

The volume is in two parts. Part I examines the various theories that have been advanced. Part II presents the facts of the problem. These are taken up regionally—the cooler seas, the marginal belts, and the true coral seas—and discussed from the standpoint of land forms. "Coral reefs must be treated as items in the geological history of their areas; and their history must include a due consideration of the processes of volcanic eruption, land sculpture, and sea-floor deposition, as well as of the changes of island and of ocean level, along with the processes of reef growth." The systematic and thorough physiographic presentation offers a new mode of approach to the problem. The illustrations are another distinguishing feature of the monograph. There are numerous reproductions from charts of the U. S. Hydrographic Office, the U. S. Coast and Geodetic Survey, and the British Admiralty; some fine photographs; numerous sketches; and most particularly that form of illustration for which the author is famous, a series of block diagrams of great beauty and clearness.

The Last Glaciation. Dr. Antevs' volume "The Recession of the Last Ice Sheet in New England" was published in 1922 as No. 11 of the Society's *Research Series*. It was the first successful working out of a glacial chronology in the western hemisphere. Since then Dr. Antevs has continued his investigation of the problem in the United States and Canada. This volume, "The Last Glaciation," summarizes results and compares with those of other investigators in a survey of the fundamental questions of the Ice Age. As Professor J. W. Goldthwait says in his preface, "The patient, accurate measuring of the clay layers, of varves, the plotting and matching of graphs, and the cautious interpreting of these as yearly records of climatic change has been a vital part, yet only a small part, of his work. Equally at home in physiography, Pleistocene botany, and zoölogy, and eager in his study of climates of the past, he has never lost sight of the large geologic and geographic problems . . . and . . . now puts his facts, his elaborate measurements, and his thoughts beside the facts and opinions of the specialists of seven continents."

EXPEDITIONS

Return of the American Geographical Society's Peruvian Expedition and of Mr. Joseph H. Sinclair's Expedition to the Ecuadorean Oriente. Announcement of these expeditions to unmapped regions of the Andes in Peru and Ecuador respectively was made in the January number of the *Geographical Review* (p. 144). Both parties have now returned after successful accomplishment in the field, and the scientific results are being prepared for publication. It is planned to include an account of Mr. Sinclair's expedition in the October number of the *Review*, while the results of the Society's Peruvian expedition by the leader, Mr. O. M. Miller, will appear in the following, January, number.

The Antarctic Expeditions of Commander Byrd and Captain Wilkins. The American Geographical Society has endorsed the plans of the expeditions of both Commander Byrd and Captain Wilkins for scientific exploration in the Antarctic in 1928–1929. The Society has also made a contribution to each expedition.

In a cable dispatch Captain Wilkins asks that the American Geographical Society make the first formal announcement of his plans and comment upon them as it may see fit. The cable reads:

"Expect using Lockheed seaplane now under construction, delivery August, for flight from Ross Sea following coast to Graham Land. Pilot and mechanic yet unchosen. With machine myself take Norwegian whaling ship leaving Panama for Antarctic via Tasmania about November 1, remaining with ship until commencing flight in January ending beside one of forty whalers operating near Graham Land and with whom will return Montevideo May next."

In length the flight will equal or slightly exceed the one just finished from Point Barrow to Spitsbergen. The coast of the Ross Quadrant that it will cover is very little known. Captain Wilkins will photograph the details of ice border, glacial tongues, mountains, and other features visible from his plane. In this way he will be able to select sites for the meteorological stations that he has long planned to establish. By continuous observations at these stations it is hoped to coördinate Antarctic weather conditions with those observed simultaneously in Australia, New Zealand, South America, and South Africa, and establish a sounder basis for long-range weather forecasts.

Commander Byrd, on the other hand, is making not a single long flight but a series of flights, along the line of which a number of supply stations will be laid down for the benefit of the geologist and other specialists who will prosecute detailed studies on the ground. The personnel will also include both a meteorologist and an aerologist, and a number of high altitude flights will be made for the study of weather conditions aloft, upon which light will thus be shed for the first time.

One of the proposed flights is over the South Pole. East and west of this line Commander Byrd will have an opportunity for important geographical discovery. A chain of mountains is known to extend northwest of Ross Sea. Byrd, on one side of this chain, and Wilkins, on the other, ought to give us for the first time knowledge of the longest unexplored mountain chain in the world—the Antarctic continuation of the great Andean Cordillera. By easterly flights from his main polar line of reference, Byrd will also be able to gather information on the continental interior. Of particular interest is the determination as to whether a depression runs across Antarctica from the Ross Sea to the Weddell Sea or whether there is a broad connection between the two principal divisions of land: in other words, as to whether Antarctica is a single great continent or two large islands. The problem has been recently discussed by Sir Douglas Mawson in the American Geographical Society's *Special Publication No. 7*, "Problems of Polar Research." Sir Douglas also hopes in time to make a study of this and other Antarctic problems on a new expedition of his own.

The American Geographical Society is preparing a special map of the Antarctic regions for the use of Byrd's and Wilkins' expeditions. Among other features it will show wind directions and lines of equal magnetic variation, so far as these are known. The scale on which the map is being compiled is approximately 1:3,000,000.

GEOGRAPHICAL RECORD

NORTH AMERICA

Commerce on the Great Lakes and Connecting Waterways. It is of interest at this time when there is much discussion of the commercial potentialities of the Great Lakes-to-Ocean waterways to make a survey of the actualities on the waterways in their present state. An excellent starting point is the volume prepared by the Board of Engineers for Rivers and Harbors of the War Department in coöperation with the United States Shipping Board ("Transportation on the Great Lakes," Washington, 1926). This report presents the physical background of the problem and detailed studies of the grain, ore, coal, and package freight movements on the lakes. It is well supplied with tables, both general and detailed, and with valuable maps showing the movement of the different commodities. Material to supplement and bring this report up to date can be found in the annual reports of the Chief of Engineers, U. S. Army (1927, Part 2) and in the annuals, "Report on the Grain Trade of Canada," published by the Dominion Bureau of Statistics. Useful figures are also to be obtained from the publication "Great Lakes-to-Ocean Waterway," by E. S. Gregg and A. L. Cricher (*Bur. of Foreign and Domestic Commerce, Domestic Commerce Ser. No. 4*, 1927). Graphic representation of wheat and flour traffic on the Great Lakes is presented in the first of the Goode-Baker Series of Economic Wall Maps, "Wheat: Production and Trade (1926)."

Grain entering into the commerce of the Great Lakes comes from sixteen states of the central and northwestern United States and from the three Canadian provinces of Alberta, Saskatchewan, and Manitoba. The four chief shipping centers are Fort William-Port Arthur, Duluth-Superior, Milwaukee, and Chicago. In 1923, 68.6 per cent of the grain exports from the upper lake ports went by water, 31.4 per cent by rail. Wheat comprises the bulk of the grain shipments from the Lake Superior ports and generally goes by water. Corn and oats predominate in the grain movements from Chicago and Milwaukee, and the tendency is to employ rail instead of water transportation.

The volume of grain carried on the Great Lakes increased nearly tenfold between 1868 and 1923, but there has been little appreciable increase in the amount moving from Lake Michigan. This is largely a matter of rates. Chicago with its excellent railroad connections is able to give all-rail rates on grain that compare favorably with the rates that include water transportation to a lower lake port and rail haul to an Atlantic port. Consequently grain from Chicago destined for Atlantic ports tends to move all-rail (Richard Hartshorne: The Significance of Lake Transportation to the Grain Traffic of Chicago, *Econ. Geogr.*, Vol. 2, 1926, pp. 274–291).

A good share of the water-borne grain exports from Chicago goes to Montreal either through the Georgian Bay ports or via the St. Lawrence. Grain from the Chicago hinterland ripens early and can be shipped before the elevators and the port of Montreal become congested with the Canadian crop. Grain traffic on the Great Lakes moves in waves. The first peak occurs as soon as navigation opens in the spring and serves to remove the last year's crop which has been stored in elevators or in ships. The peak of the United States shipments comes in August, closely followed by the Canadian which lasts up to the close of navigation. By the time the Canadian grain enters the field, congestion on the Montreal route, combined with the shorter season of navigation on the St. Lawrence, tends to divert much Canadian grain to United States ports. During the winter, grain stored at the Georgian Bay ports or at Montreal is sent by rail to St. John, Halifax, Portland, or even Boston. Canadian grain movements are summarized in "The Transportation of Canadian Wheat to the Sea," by L. M. Fair, and "The Port of Montreal," by L. C. Tombs (*McGill Univ. Econ. Studies in the Natl. Problems of Canada, No. 1*, 1925, and *No. 6*, 1926). Buffalo is the chief receiving port for lake grain. Here some is transshipped via the St. Lawrence to Montreal; some goes by rail to Montreal, New York, or other Atlantic ports; and some is converted into flour. New York owes much of its attraction as a grain-shipping port to the great amount of shipping that centers there. Grain is a very desirable dead-weight cargo for liners, and frequently the competition to secure this cargo is such that ocean rates from New York offset any increase in price the rail haul to that port may have made over rates on the Montreal route.

In 1923 ore shipments constituted about 50 per cent of the total volume of traffic on the Great Lakes. The ore mined in the Lake Superior district is hauled a short distance to water and loaded on ore vessels by special apparatus. The bulk of the ore moves from Lake Superior to Lake Erie ports, whence it goes to the steel centers of Ohio and Pennsylvania. An important deflection from this great ore stream is that to the Calumet-Gary district at the southern end of Lake Michigan. Water transportation with its highly organized methods of handling ore permits an average saving of $2.71 a ton over the probable rail rate.

Shipments of coal in 1923 made up about 25 per cent of the volume of lake traffic for that year. Originating in the bituminous fields of the Appalachian trough and the anthracite region of Pennsylvania, this commodity furnishes a west-bound cargo for the grain and ore boats. The ore-receiving ports are not, however, the chief coal-shipping ones. Anthracite is generally sent from Buffalo; and, although Ashtabula, Conneaut, and Cleveland all contribute to the lake flow of bituminous coal, Toledo alone exports 30 per cent of it (Port Study, Toledo [Ohio] Port Commission, 1924). The total coal shipments do not suffice to provide return cargo for all the grain and ore boats; and consequently there is lively competition which, with its attendant reduction in rates, makes it possible for eastern coal to compete in the north-central part of the continent with coal mined in the Middle West, particularly in Illinois. Most of the lake coal moves to Lake Superior ports. The majority of the imports at the Lake Michigan ports are of anthracite or of grades in which Illinois is unable to compete.

A detailed examination of an industrial district adjacent to the Great Lakes throws more light on the commercial significance of the inland waterway. Such a study has been made by Professor J. B. Appleton (*Univ. of Illinois Studies in the Social Sciences*, Vol. 13, No. 2, 1925) for the Calumet iron and steel district, situated near Chicago on the south shore of Lake Michigan. This district supplies, at a lower cost than elsewhere, a little over 20 per cent of the steel produced in the United States.

Quite in contrast to the heavy traffic on the Great Lakes is the lack of activity on adjacent waterways, including the New York Barge Canal. During the navigation season of 1926, 2,400,000 tons moved over the canal, a poor showing for a route connecting the Great Lakes with New York, the chief port of the country. Many reasons for the lack of business on the Barge Canal have been given: goods must be transshipped; transshipment and terminal charges eat up any saving gained by using the canal; traffic is slow; equipment is clumsy; and the navigation season is limited. However, the Barge Canal is becoming better equipped, and its traffic may improve. The new Welland Ship Canal will be large enough to allow most vessels on the Great Lakes to enter Lake Ontario. As a consequence ports like Oswego may regain some of their former importance. It will soon be possible for grain freighters to discharge their cargoes at Oswego instead of Buffalo, whence the trip to New York either by rail or canal is much reduced (see "Great Lakes Commerce and the Port of Oswego, New York, 1925," Report . . . by Fay, Spofford and Thorndike, 2 vols., Harbor and Dock Commission, Oswego, N. Y., 1927).

The Illinois Waterway, to consist of the Sanitary Ship Canal of the Chicago Drainage District and the deepened and canalized sections of the Illinois River, is in some ways a parallel to the New York Barge Canal. Not a great deal of traffic originates along this waterway; the population is scattered; and there are few large towns. Present industries are now well established with reference to rail routes, which are admittedly adequate to handling all the traffic. Miss B. L. Ashton has surveyed the situation in "The Geonomic Aspects of the Illinois Waterway" (*Univ. of Illinois Studies in the Social Sciences*, Vol. 14, No. 2, 1927).

A Reconstruction of the Natural Vegetation of Ohio. In his reconstruction of "The Natural Vegetation of Ohio" (*Ohio Journ. of Sci.*, Vol. 25, 1925, pp. 139–149; Vol. 26, 1926, pp. 128–146, 213–231) Paul Bigelow Sears accomplishes in small compass an ambitious task and one of geographical interest beyond the immediate theme. The method he employs is one that could be applied with success to a study of the soils, land forms, and drainage patterns of the natural landscape wherever survey records are preserved.

Dr. Sears prepared his map of the virgin forest by transcribing the species of bearing trees recorded at section corners in the original land surveys by the early surveyors. It was in Ohio that Thomas Hutchins, first and only "Geographer of the United States of America," inaugurated the use of the so-called township system of land surveys. All corners which lay within the forest were located with reference to near-by trees, the species of which were noted. The Ohio surveys were begun in July, 1786, and were run by trained woodsmen who generally observed and recorded the species correctly and made few serious errors in location. The surveys thus provide the botanist with authentic observations as to the character of the vegetation at the points of intersection of all meridians and parallels, spaced at intervals of a mile.

The reconstructed map of vegetation is correlated with present and preglacial topography and soil with the result that the author ventures the following prophecy. "*There have been no accidents.* In fact, so striking is the relation between preglacial topography and natural vegetation that the writer does not hesitate to express his belief that a great preglacial valley will probably be found running northward through Champaign, Logan, Hardin and Hancock counties." He finds that there were three characteristic species groups within the state, oak (black oak, white oak, hickory, etc.), beech (beech, sugar maple, etc.), and ash (black ash, white ash, elm, maple, etc.), and that these species groups within the glaciated region were primarily correlated with the moraine system. "Broadly speaking, beech tended to appear along the side, ash upon the central ground, and oak toward the central terminal region of the glacial lobes." The prairies, occasionally fairly extensive—embracing from fifty to one hundred square miles, were found to have been edaphic and to have been correlated with the glacial moraines. Prairies were completely absent in unglaciated parts of the state. These were not climatic grasslands nor were they due in any measure to aboriginal firing. The author has located many unforested prairies which had been obscured or destroyed by secondary successions introduced by white men.

C. W. Thornthwaite

Mountains of Southeastern Idaho. A comprehensive geological essay on southeastern Idaho by G. R. Mansfield (*U. S. Geol. Survey Professional Paper 152*, 1927) includes many statements of physiographic import, among which the most significant is that which explains the mountain ranges as showing in their highlands the remains of a peneplain developed on a mass of folded, faulted, and overthrust strata when the region stood lower than now; the intermont valleys being the result of dislocations and of erosion while and after the wide-spread peneplain was broadly uplifted. A similar result is announced for many ranges in Siberia by Obruchev

(Geologie von Sibirien, Berlin, 1926), who says that fault-block mountains, the folded structures in which had been greatly eroded after their earlier production, there play the first rôle. Where, then, are any large mountain ranges to be found now in the cycle of erosion that was introduced by the folding of their rocks?

W. M. Davis

SOUTH AMERICA

The Peru-Colombia-Brazil Boundary Agreements. As the result of agreements reached in a series of meetings of representatives of the governments of Peru, Colombia, and Brazil, called in Washington in March, 1925, considerable progress has been made toward the settlement of the highly complicated and long-standing boundary disputes involving the counterclaims of Peru, Ecuador, Colombia, and Brazil in the territory east of the Andes between the Caquetá, or Japura, and Amazon rivers.

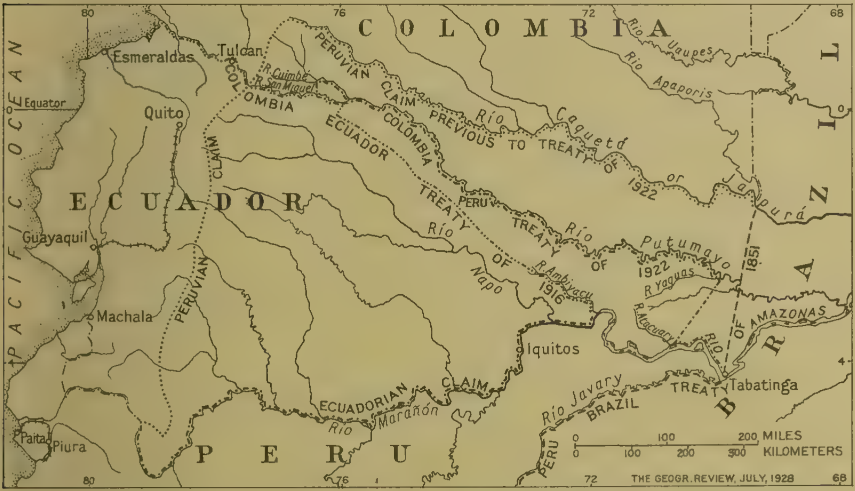

Fig. 1—Sketch map showing the new Colombia-Brazil and Colombia-Peru boundaries and the extent of the counterclaims of Ecuador and Peru. Colombia has relinquished the claim against Brazil to the point of territory between the Putumayo and Amazon rivers east of the Apaporis-Tabatinga line. No mention is made in the Colombia-Peru treaty of the disposition of counterclaims to the territory north of the Colombia-Ecuador boundary of 1916 between the San Miguel-Cuimbé line and the western boundary of the Peruvian claim previous to the treaty. Scale approximately 1:13,000,000.

At these meetings it was agreed on the part of Colombia and Brazil that a treaty would be signed in which Colombia would recognize as her boundary with Brazil the line from Tabatinga on the Amazon River to the mouth of the Apaporis River in the Putumayo River (defined by Peru and Brazil as their common boundary by the treaty of October 23, 1851) and relinquish her claim to the strip of territory between the Putumayo and Amazon rivers east of this line, and in which Brazil, in return, would grant to Colombia freedom of navigation in perpetuity on all navigable streams common to both countries.

It was agreed on behalf of Colombia and Peru that the unratified boundary treaty signed by representatives of these countries on March 24, 1922, would be ratified. This ratification has now been effected, by Colombia on October 30, 1925, and by Peru on December 20, 1927. It defines the boundary as a straight north and south line from the San Miguel, or Sucumbios, River (defined by Colombia and Ecuador by the treaty of July 15, 1916, as forming a part of their common boundary) to the mouth of the Cuimbé River in the Putumayo River; thence down the Putumayo

River to the mouth of the Yaguas River; thence by a straight line from the mouth of the Yaguas River to the mouth of the Atacuary River in the Amazon River; and from there down the Amazon River to the Tabatinga-Apaporis line. Colombia thereby retains a corridor from the Putumayo to the Amazon between the Yaguas-Atacuary line and the Tabatinga-Apaporis line, recognizes the Tabatinga-Apaporis line as her boundary with Brazil, and relinquishes her claims to territory east of it between the Putumayo and Amazon rivers.

Ecuador was not a party to the Washington conferences nor to any of the agreements arrived at by those conferences. The most important of the disputes in the region, that of Ecuador and Peru, is, therefore, still unsettled. As defined by the extreme claims of the two countries, it involves an enormous triangular area bounded by the Colombia-Ecuador boundary of the treaty of 1916, the Marañón River, and the crests of the Eastern Cordillera of the Andes. The dispute is now further complicated by the fact that Colombia has resigned to Peru territory north of the boundary established with Ecuador in 1916.

The Colombia-Peru treaty states that "the high contracting parties declare that there remain definitely and irrevocably terminated all and every one of the differences with regard to the boundary between Peru and Colombia which have arisen up to the present time and that in the future nothing may arise to alter in any form the line of the boundary fixed by the present treaty." It will be noticed on the accompanying map, however, that north of the boundary established by Colombia and Ecuador and between the Cuimbé-San Miguel line and the western limit of the Peruvian claim against Ecuador and Colombia previous to the 1922 treaty is an area of which no mention is made in the treaty. In fact the treaty does not describe or even mention the boundary west of the Cuimbé-San Miguel line.

EUROPE

Geographical Aspects of the Tourist Industry in Italy. The tourist industry in Italy has of late been made the subject of quantitative studies by the Enit (Ente Nazionale per le Industrie Turistiche). The investigations, in so far as they relate to the movement of tourists, were discussed at the Tenth Italian Geographical Congress by the Director-General of the Enit, Professor Angelo Mariotti (*Atti del X Congresso Geografico Italiano*, Vol. 2, Milan, 1927, pp. 539–550). Tabulations of the number of foreigners registered with the police, of the number of railway tickets sold, and of guest taxes levied upon hotels of the first and second class furnished statistical bases for the studies, but unfortunately—Professor Mariotti is obliged to explain—the figures are incomplete and misleading. They suffice, however, to give a view of the relative, if not of the absolute, flow of tourists to the different provinces of Italy at different times of year. The facts are presented for 1926 in tables and on diagrammatic maps.

Italian and foreign tourists do not flock in proportionately equal numbers to the same regions. Taking 1926 as a whole, Tuscany, Lombardy, Liguria, Lazio (Latium), and Sicily, in the order named, were most visited by Italians; and Sardinia, followed by Umbria, was least popular. The density of foreign tourist traffic was greatest in the northeastern provinces: Venezia Tridentina (including the Italian Tirol), Venezia Giulia (including Istria), and Veneto; Liguria came fourth and was followed by Lazio and Tuscany. Fewest foreigners visited the Abruzzi, Calabria, and Basilicata. It is noteworthy that Lazio, the province which includes Rome, was not the most attractive to tourists either from within or without Italy. Only in December, 1926, did Lazio hold first place in the number of foreign visitors. In January, February, and November, Liguria (i. e. the Italian Riviera) was the favorite resort of the foreigners; in March, April, and September, Venezia Tridentina and from May to August, inclusive, Venezia Giulia stood first; in October Veneto headed the list.

Professor Mariotti stresses the need for similar, but more intensive and exact, studies, since the "movement of foreign tourists . . . . represents the most conspicuous asset on our international account book . . . ." Such studies might well be undertaken for those parts of the United States (northern New England, for example) where the tourist industry is one of the major economic resources of the native population.

The leading Italian organization devoted to the interests of tourists is the Italian Touring Club. Like its Swedish counterpart (see *Geographical Review*, Vol. 13, 1923, pp. 608–612), the Italian organization is carrying on geographical work of high merit (Touring Club Italiano: L'attività geografica del T. C. I. nel triennio 1924–1926: il "Grande Atlante Internazionale del T. C. I.," Milan, 1927). Founded in 1894, the Club has had a phenomenal growth: by 1926 the membership had reached 400,000. "It is not a rash assertion that the only books, other than schoolbooks, which enter a great many Italian households are those of the Touring Club." The publications consist of maps, guides, periodicals, and recently of a superb atlas of the world. The fundamental map of Italy is in 59 sheets and covers the entire kingdom on a scale of 1:250,000. Publication has been undertaken of extremely accurate and beautiful special maps on large scales (1:50,000; 1:25,000) of regions of exceptional interest to the tourist. Sheets for the Dolomites in the vicinity of Cortina d'Ampezzo and for Palermo with the Conca d'Oro have already appeared, and the completion of maps of Monte Rosa and of the Riviera from Genoa to Sestri Levante is announced for 1928. As a memorial to the late Signor L. V. Bertarelli, who held the position of Director-General from 1906 to his death in 1926, the Touring Club has issued a handsome illustrated volume containing reprints of many of Bertarelli's popular and semipopular articles (Touring Club Italiano: L'Italia e il Touring negli scritti di Luigi Vittorio Bertarelli, Milan, 1927). Seven studies deal with the activities of the Club, twenty with people and places. Among the remarkable illustrations are views of Italian hill towns showing the nearly inaccessible sites on which settlements were established in earlier days and where the population still lingers in spite of inconvenience and actual hardship imposed by the difficulty of approach.

Changes in the Frontier of the French Language since 1806. In 1806, under Napoleon, an investigation of the linguistic situation in France was undertaken. Through a questionnaire submitted to the prefects information was accumulated defining the topographical limits of the French tongue. The unpublished original records in the Archives Nationales and Bibliothèque Nationale are discussed by Ferdinand Brunot in the Appendix to Volume 9 of the "Histoire de la langue française" (Paris, 1927). On the basis of Brunot's study, Albert Dauzat presents (*La Nature*, No. 2775, 1927, Dec. 15, pp. 529–535) a succinct statement illustrated with diagrammatic maps of the principal changes that have taken place in the linguistic frontiers since 1806.

Within France, the areas of French speech have in places advanced, and almost nowhere have they fallen back. In the southwest, however, Basque has held its ground more firmly than has Breton in the northwest. French is making steady progress at the expense of Breton, particularly along the coast of the *département* of Morbihan and along the two national highways from Rennes to Brest. Flemish, also, has been pushed back both in France and Belgium. In Lorraine eastward movements of segments of the French-German linguistic border have occurred near Metz and Chateau Salins, owing, perhaps, to the influence of these towns as "foyers de francisation." In this connection, Dauzat observes that "the linguistic boundary here almost never coincides with a geographical boundary; it cuts across valleys, rivers, and great commercial arteries." In Alsace the line has been remarkably stable. "In Switzerland French has fallen back a little on the north before a powerful ethnic pressure; on the south it has absorbed several German-speaking islets in the Valais."

No sharp line can be drawn delimiting the area of French speech on the southeast. Intermediate dialects, Franco-Provençal and Provençal, Piedmontese, and Genoese bridge the gap between French and Italian. As the literary language of the Piedmontese valleys, Italian, which has the advantage of being the national tongue, has been persistently gaining territory at the expense of French.

AFRICA

The Italian Occupation of Fezzan in 1914. Fezzan, the Roman province of Phasania, forms the Saharan hinterland of Tripolitania. Although since 1912 it has belonged in name to Italian Libya, Fezzan has been held by the Italians for about six months only. An expeditionary force under Colonel Antonio Miani seized Murzuk, the capital, in March, 1914; Ghat, lying to the west, was also taken; local rulers proclaimed their submission to the Italian government; and for a short while it appeared as if Fezzan had been permanently incorporated in the Italian colonial empire. The diary of Dr. Guido Rellini, who accompanied the Miani expedition, has recently been published (*Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 4, 1927, pp. 260–285, 383–412, 497–557). The Senussi, however, who were strongly represented in Fezzan, seized their opportunity upon the outbreak of the World War, and the Italians were compelled to evacuate.

In 1926 Corrado Zoli, who had visited Fezzan in 1914 as a newspaper correspondent, published a volume entitled "Nel Fezzan: Note e impressioni di viaggio" (Alfieri & Lacroix, Milan). This book, despite its title, is more than the usual collection of travel notes and impressions. Besides a record of the history of the Miani expedition and the attendant circumstances, the author has set down personal observations of scientific value, together with much important information about the land and people gathered from natives and Italian officials.

On all sides but the east the frontiers of Fezzan are fairly well marked by relief features. On the north the barren, rocky plateau of Hammada el-Homra in Tripolitania falls off to the Saharan sands of Fezzan in a long escarpment that roughly follows the 28th parallel of latitude. Fezzan itself comprises tracts of sand separated by rocky uplands. The population is concentrated in widely separated oases strung along generally northeastward-trending wadies. The climate is typically Saharan: very dry with extreme diurnal ranges of temperature and occasional violent windstorms. Inhabitants of Murzuk asserted that no rain had fallen there since 1866; although Zoli doubts the literal truth of this, he adds: "The boys of Murzuk with whom I talked did not remember ever having seen rain, and they showed that they had no exact conception of what is meant by the term." The maximum daily range of temperature observed during the summer was 36.4° F. (from 78.6° F. to 115° F.). Zoli believes a gradual progressive desiccation of the Sahara is in progress and that Fezzan in classical times was more prosperous than now. The Romans held the province of Phasania mainly because it included magnificent hunting grounds whence wild beasts could be obtained for the circuses and because the population could be drawn upon for slaves. (In a scholarly article in *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 5, 1928, pp. 171–213, Dr. Dino Gribaudi discusses the questions of the changes in the climate of Libya during historical times, concluding that the climate "will not prevent this colony in the near future from becoming worthy of its ancient grandeur." The study is confined to the coastal regions, however.)

Zoli criticizes earlier travelers for having fallen into the error of assuming that the people of Murzuk are representative of the population of Fezzan as a whole. The latter is enormously mixed, with great variations from settlement to settlement. There is a fundamental cleavage between the *ahali*, or sedentary villagers—for the greater part Sudanese, intermingled with Berbers and Arabs—and the *orban* ("Arabs"), or nomads of Tuareg and Tebbu stock. The total population of Fezzan is estimated at about 110,000.

In 1914 Murzuk had some 700 inhabitants; including the surrounding oasis, about 1400. Explorers of a half century ago ascribed to it a population of 25,000 or 30,000; but these figures must be exaggerated. From conversations with well-informed old men Zoli concludes that the maximum even in the most flourishing period could not have exceeded 7000. Depopulation and decadence have followed the stopping of the slave trade and the traffic in arms. Furthermore, Saharan commerce is being diverted through the railways and ports of the surrounding European colonies. Formerly a great fair was held each year at Murzuk; for four or five months a temporary population equal to that of the city itself assembled there.

Notes on the Climate of the Sahara: In a recent report Professor O. Olufsen records some observations on the climate of the central Sahara made in large part on a recent journey south from Tuggurt and Wargla through the Ahaggar to Tamanrasset and thence, returning, across the Western Erg sands to the railroad near the frontier between Algeria and Morocco. A vivid general description is followed by meteorological notes taken daily and by a brief narrative of the route.

Dr. Olufsen's journey was made in winter, and hence the highest temperature recorded did not exceed 104° F. He believes, however, that about 140° F. is the probable summer maximum attained anywhere in the Sahara. The sand when the sun beats down on it becomes heated to an extraordinary degree. In skirmishes "it is sometimes impossible for infantry soldiers to lie down; they stand up, preferring the risk of being killed by bullets, rather than that of allowing themselves to be burned to death on the sand." And yet the heat does not penetrate more than a few inches below the surface; at a depth of a yard the temperature of the sand probably does not vary from day to day but is influenced only by the annual march of the atmospheric temperature. At sunset the thermometer may frequently fall as much as 70° F. within a few minutes. In winter there are always a considerable number of days with frost, a minimum of $-22°$ F. having been recorded at In Salah.

Like all travelers in the desert Olufsen emphasizes the scarcity of the precipitation but its torrential nature when rain actually falls. The water either evaporates or sinks rapidly into the sand and interstices of the rocks. Thus high rocky plateaus, while excessively dry at the surface, may act as reservoirs, collecting the rain water within them and distributing it to the oases in the low ground around their margins.

Strong gusty winds blow over the desert most of the time, and there is always fine sand in the air. Olufsen gives an exceptionally striking account of the wind storms of the desert, with their clouds of suffocating sand and dust which often menace the traveler's life. The frequent sand whirls, on the other hand, are neither disagreeable nor dangerous, but in their freakish antics provide constant amusement. (O. Olufsen: Mission O. Olufsen au Sahara 1922–23: Le climat du Sahara: Observations météorologiques, Copenhagen, 1926.)

ASIA

Afghanistan in Transformation. A French writer thus characterizes present-day Afghanistan: "a backward country where Oriental and Occidental civilizations fall afoul of one another: here we find seven-ton motor trucks, but no roads to run them on; aircraft, but no mechanics to operate them; an Emir with very modern ideas, governing an indifferent or even restive population; and a great many foreigners suddenly attracted into a country that, five years ago, was totally closed to the outer world" (Raymond Furon: L'Afghanistan: Géographie, histoire, ethnographie, voyages, Paris, 1926). Amanullah Khan, the ruling King (he adopted this title in 1926), succeeded his father in February, 1919. In the following May he embarked upon a war with Great Britain which soon ended in the crushing defeat of the Afghan army. The war was followed, however, in 1919 and 1921 by treaties that were advantageous to Afghanistan, whose complete "internal and external independence was recognized." From these treaties and from treaties concluded at about the same time with the Soviet and the Turkish government may be dated the beginnings of Amanullah's attempted modernization of his country (see Arnold Toynbee: Survey of International Affairs 1920–1923, London, 1925, pp. 376–388; *idem:* Survey of International Affairs 1925, Vol. 1, London, 1927, pp. 546–569). His recent visit to Europe is in line with this policy. Lowell Thomas gives a colorful account of the glaring contrasts in the Afghan scene in his "Beyond Khyber Pass" (New York, 1925).

The most serious recent contribution to the geography of Afghanistan is the work of a German scholar, Dr. Emil Trinkler ("Afghanistan: Eine landeskundliche Studie auf Grund des vorhandenen Materials und eigener Beobachtung," *Petermanns Mitt. Ergänzungsheft No. 196*, 1928). In 1923–1924 Dr. Trinkler traveled from Kushk to Herat, Kabul, and Peshawar, with a side trip into the western Hindu Kush, and he has supplemented his observations in the field by an extended examination of the published literature. A valuable collection of rock specimens made by Dr. Oskar von Niedermayer in the course of a German military mission in Afghanistan during the World War was also placed at Dr. Trinkler's disposal. The latter asserts that the microscopic analysis of these specimens at the Petrographic Institute of the University of Munich was "the first investigation of Central Asiatic rocks that has been carried out on a modern basis." The Niedermayer collection was of no little value in the geological interpretation of portions of Afghanistan. Trinkler's monograph is a systematically organized regional study covering physical, biological, and human geography. (An English version of Dr. Trinkler's popular volume "Quer durch Afghanistan," entitled "Through the Heart of Afghanistan" and edited and translated by B. K. Featherstone, is also available.)

In this connection reference may also be made to Oskar von Niedermayer's "Afganistan" (Leipzig, 1924), in which a splendid sequence of photographs constitutes the essential part of the volume.

The Weather and Climate of China. The present widespread interest in China is not limited to the political situation. Many questions are being asked concerning the physical conditions, the floods, the topography, the climate. Two publications on the weather and climate of China have recently appeared. From Dr. Co-ching Chu, of the National Southeastern University of China, comes a six-page "abstract" entitled "A Preliminary Study on the Weather Types of Eastern China." It is based on the daily weather maps issued at Shanghai, Hongkong, Nanking, Tsing-Tao, and Peking from January, 1924, to June, 1926.

Eastern China and the eastern United States have much in common meteorologically and climatically. In fact, in many classifications of the world's climates they are placed in the same subdivision. As Dr. Chu points out, the weather types of the two areas are strikingly similar with two major differences. The Siberian anticyclonic conditions are so well developed and so dominant in winter that very few storms invade Manchuria and northern China in that season. Hence the weather is distinctly more "settled" than it is in the northeastern United States, and the rainfall is very light. On the other hand, in summer the number of typhoons is greater along the coast of South China than is the number of West Indian hurricanes along the coast of the southern and southeastern United States. Therefore the typhoon control of weather changes in southern and central China is more marked than is the hurricane control in this country.

The winter weather types of eastern China are named according to the locations of the anticyclones, while the summer types are designated by the nature and positions of the low-pressure areas. In the warmer months the centers of action change, and the solar control becomes very marked. Indeed, the regular diurnal variation of the barometer is characteristic, and the weather types tend to persist, varying much less than in winter. Well developed cyclones, so characteristic in the United States and in Europe, are but seldom observed in China. These disturbances are usually "stunted" in their development, at least before they reach Japan. Therefore cyclonic rainfalls are very light, and this is true even in the lower Yangtze Valley, where they attain their maximum development. The reason, according to Dr. Chu, lies in the fact that the Siberian anticyclone is so dominant in winter that no cyclones of any considerable size can exist on the continent. In summer, on the other hand, "the increasing solar control also excludes the possibility of their development."

A summary of the essential facts concerning the climate of China has been given by C. E. Koeppe and N. H. Bangs ("The Climate of China," *Monthly Weather Rev.*, Vol. 56, 1928, pp. 1–7). The monsoons; weak cyclonic storms in the colder months; the typhoons of summer; the topography; the ocean to the east, including the warm Kuro-siwo current, are listed as the dominant climatic controls. The winter monsoon (N. W.) imports low temperatures into the southernmost districts. "All China shivers down to the tips of its toes—even to Hongkong, the world's coldest subtropical city." Shanghai, in the same latitude as Savannah, Ga., is 14° colder in winter than that American city. Hongkong is some 10° colder than Key West, which lies about 3° of latitude farther north. The winter dust storms of Peking, brought by the violent northerly winds, are well known. In summer northern China is warmer in the mean than the corresponding latitudes in the United States, but absolute maxima of 100° or more are rare.

Rainfall is heaviest in summer, when the prevailing winds are southeast and bring in an abundant supply of water vapor, especially where a forced ascent occurs over mountains or in convectional overturns. The winter winds are continental in origin; they are cold and bring little precipitation. Droughts are distressingly frequent in North China and floods in the northeast. Typhoons are unfortunately frequent and are most disastrous on the coast of South China. They fortunately weaken rapidly as they move inland. As in the eastern United States, however, when they travel inland they may assume the characteristics of ordinary extratropical cyclones and, moving northeastward, may cause heavy rains in central and even in northern China.

R. DeC. Ward

AUSTRALASIA AND OCEANIA

A Report on the Newly Created Territory of Central Australia. The Northern Australia Act of 1926 provided for the division of Northern Territory into two portions: the area north of 20° S. latitude being known as North Australia, with seat of government to be established "as soon as practicable at Newcastle Waters," that to the south as Central Australia, with seat of government at Alice Springs.

It is hoped by such a step to inaugurate a greatly needed "programme of progress." In his illuminating "Report on Northern Territory: Development and Administration" (1925), Sir George Buchanan pointed out that the population of the Territory declined from over 5000 to under 3000 in 1910. In 1921 it was 3867, exclusive of full-blooded aboriginals, who are estimated at some 20,000. Administration of the Territory has been expensive: in 1924 the deficit was four times as great as the revenue.

Some interesting figures on the newly created southern division are given by the Government Resident in the first report on his administration (Canberra, 1927). The area of Central Australia is 236,393 square miles; the population 411. There are more than 85,000 head of cattle, more than 15,000 horses, nearly 10,000 goats, more than 6000 sheep, and several hundred camels. In nine years of record the rainfall at Alice Springs ranged from 4.39 inches (1918) and 5.38 (1924) inches to 28.58 (1920) inches. The absolute range of temperature was from 106° F. to 25° F. From

Alice Springs to Adelaide the distance is over 1000 miles; to Sydney 2100 miles; to Perth and Brisbane over 2200 and 2800 miles respectively. The nearest medical assistance is 331 miles away at Oodnadatta. No wonder "the pushing forward of the railway from Oodnadatta to Alice Springs has given the people of these parts fresh heart."

The Resident, however, points out that "the exploitation of the artesian and sub-artesian resources of the country should synchronise with the coming of the railway." He had arrived at his post at an opportune time to judge of such needs. "I found the whole of the country, with the exception of that portion north of Woodford, suffering from severe drought. . . . I started out with camels on a tour of inspection of the settled area comprised in the western district. During the whole of the journey, which occupied three weeks, I was confronted with the same set of circumstances—practically the absence of all surface waters; the country for miles in the vicinity of wells being denuded of fodder, and when feed was available it was useless on account of being too far removed from existing waters. . . . If Central Australia is to take its place as an inland colony, a vigorous policy of water conservation must be carried out."

THE OCEANS

The Geography of the Andaman Sea Basin. Through the eastern part of the Bay of Bengal extends a north-south chain of islands which subdivides the Bay into a larger western part, known as the Bay of Bengal proper, and a smaller eastern part called the Andaman Sea. This smaller sea, lying between the island chain and the mainland of southern Burma and the Malay Peninsula, is the subject of a study by R. B. Seymour Sewell: The Geography of the Andaman Sea Basin (Geographic and Oceanographic Research in Indian Waters, Part I, *Memoirs Asiatic Soc. of Bengal*, Vol. 9, 1925, pp. 1–25).

The island chain, extending in a gentle arc from near the delta of the Irrawaddy River some seven hundred miles to Sumatra, represents the emerged higher parts of a great mountain range forming the western rim of the Andaman Basin. Igneous rocks make up part of the range, but conglomerates and sandstones are present. Extensive deposits of clay, by some regarded as true deep-sea ooze raised from the sea floor by the mountain upheaval, are accepted by the author, following conclusions of Tipper and Oldham, as comparatively shallow-water deposits derived from decomposition of older serpentine rocks.

As the mountain range was upheaved, the Andaman Sea Basin is believed to have subsided, probably in Pliocene or early Pleistocene time, beginning as a shallow basin into which the Irawaddy and other rivers poured their waters. The weight of these waters is regarded as a possible factor in producing the subsidence. That the uplift of the mountain range is still in progress in places is regarded as probable. Uplifted coral reefs are found in many places, terraces of coral limestone to a height of 60 to 80 feet at one point, a cave in weather-worn coral limestone 200 feet above sea level at another. Submerged stumps and other supposed evidences of recent subsidence, as well as certain evidence of coastal stability, are overruled in favor of the theory of a recent elevation of the land or fall of sea level.

The deep channels across the island mountain range, connecting the Andaman Sea with the Bay of Bengal proper, are regarded as lines of fractures cutting the range transversely. Presence of the same kind of rock on both sides of a channel and similar topographic appearance on both sides seem to be accepted as proofs of fracture. Specialists in building land bridges from one land mass to another will be interested in the author's conclusion that the theory of a former land connection between the island and the mainland is open to strong objections.

The islands are bordered by a "continental shelf" of disputed origin. The author regards this feature as due partly to erosion, partly to deposition of sediment, and partly to outward building of coral banks. Out beyond the shelf, and below it, are ridges and valleys believed to be parts of a stream-eroded land topography carried down to a depth of at least 1100 fathoms. But a deep "gully" off the delta of the Irrawaddy is not accepted as a drowned part of the Irrawaddy Valley; it crosses the newly deposited continental shelf and "must be a new formation due to the deposition of silt and mud along certain definite lines and due to equally definite causes, the most important of which are the effect of mixture between the silt-laden river water and the more saline waters of the sea" and the deflection of the river current by a marine current off its mouth. The asymmetrical cross section of some of the islands, with steeper slope to the east, is thought to support Brouwer's idea of an anticlinal uplift of the mountain range with progressive advance of the anticlinal "wave" from west to east. Such advance should cause continuing uplift of land on the east and corresponding subsidence on the west. Facts are cited which in the author's opinion establish the reality of such changes of level.

It will be evident that the author has in a few pages touched on many difficult problems, some of them highly theoretical. The reader may hesitate to follow him in all of his conclusions, both those representing an effort to evaluate the work of authorities cited and those based on the author's own observations. But one will none the less find value in this résumé of what is known concerning the physical features of the Andaman Sea Basin and in the author's own contributions to our knowledge of the area.

DOUGLAS JOHNSON

PHYSICAL GEOGRAPHY

Three Recent Ecological Studies of Geographical Interest. Three recent investigations of the relations of plant and animal life to environment illustrate some of the many trends in modern ecology that are of obvious geographical interest.

One is a study of the crater plants of Java (F. C. von Faber: Die Kraterpflanzen Javas in physiologisch-ökologischer Beziehung, Weltevreden, 1927). The slopes of the Javan volcanoes are generally forested. At the lower altitudes tropical rain forest is typically developed; near the summits, the climber reaches the "so-called cloud forest with its stunted trees and abundance of mosses and ferns." In and about the craters of the inactive volcanoes, on the lava detrital slopes (Geröllhalde) of the active cones, around the solfataras, and in certain upland bogs (Hochmoore) a very different type of vegetation is found. In spite of differences in the altitude and climate of these various habitats, this second type of vegetation is sufficiently homogeneous to constitute a single association, the "crater association." Where the latter occurs near a solfatara the contrast is marked between the encircling dark and high-trunked rain forest and "the low shrubs and herbs" of the crater association "growing out of a grayish-white or yellowish-white soil and swathed in a veil of steam and sulphurous fumes." Von Faber attributes the distinguishing characteristics of the crater association primarily to edaphic conditions—that is, to the character of the soil—and only secondarily to climatic circumstances. Near the solfataras the principal control over plant growth is to be sought in the effects produced by the chemical gases upon the soil.

Ecological research of more directly practical application is illustrated in two papers dealing with widely divergent environments in the United States. Percy Viosca, Jr., of the Department of Conservation of Louisiana, argues in favor of what he holds to be a more rational policy in relation to the "wet lands" of that state ("Louisiana Wet Lands and the Value of Their Wild Life and Fishery Resources," *Ecology*, Vol. 9, 1928, pp. 216–229). The wet lands—in other words, the swamps, fresh and salt marshes, lakes, and bayous of the Mississippi flood plain and delta—comprise one-third of the total area of Louisiana. Viosca estimates the annual money value of the game, fish, shellfish, furs, alligator hides, frogs, turtles etc., obtained from them at $20,500,000. In addition, the wet lands possess a great but imponderable value as a recreational area and, from the scientific point of view, as the last resort of many rare varieties of plant and animal life. The construction of navigation and drainage canals and the extension of levees along the main streams has resulted in the lowering of the ground water table under a considerable part of the wet lands and in the lowering of the surface of lakes, bayous, and swamps. The consequent droughts and fires have led to widespread destruction of wild life. This has not only meant a loss in natural resources incommensurate with any gain to agriculture, but has reacted indirectly to the disadvantage of the agricultural population. Pests of mosquitoes and crop-destroying insects have increased with the destruction of a bird and animal life that would have kept them in check if the normal balance of nature had been maintained. Viosca advocates the "restoration of those natural conditions best suited to an abundant marsh, swamp, and aquatic fauna, but under some degree of control at all times . . . ."

In the arid lands of our West certain plants do not draw the water indispensable to their growth directly from the atmosphere or surface water but send down their roots to the ground water level. These plants have been studied by O. E. Meinzer, who presents the results of his research in *U. S. Geol. Survey Water-Supply Paper 577*. Some plants go much deeper than others. "With a few exceptions, the greatest depth from which ground water is known to be lifted by plants is about 50 feet." Alfalfa roots, however, have been reported in a mine tunnel in Nevada at 129 feet below the surface. Some plants depend almost altogether on ground water, others do so only in part, others do not do so at all. The utility of familiarity with the habits of different plants in this respect is manifold. Not only does such knowledge enable one to determine "where water supplies may be developed by digging or drilling," but for persons lost in the desert or otherwise in distress the clues furnished by plants "may be a matter of life or death."

GEOGRAPHICAL NEWS

"Arktis," a New Journal for Polar Research. A new quarterly journal dealing with the Polar Regions has appeared as the organ of the International Association for the Exploration of the Arctic by Airship, whose seat is in Berlin. It is entitled *Arktis* (*Vierteljahrsschrift der internationalen Studiengesellschaft zur Erforschung der Arktis mit dem Luftschiff*). Dr. Fridtjof Nansen is the editor, and the geographical firm of Justus Perthes are the publishers.

The main aim of Aeroarctic, as the Association is called for short, is to make possible continuous observation of physical phenomena in the Arctic, mainly by means of permanent stations similar to those established in the Polar Regions by international coöperation in the years 1882–1883. As a preliminary the Association originally had in mind a reconnaissance flight by airship across the Arctic Basin and back. This was prior to the *Norge*, Wilkins, and *Italia* flights. The prime object remains, however; and it is hoped to be able to carry it through. The main sponsor of this phase of Aeroarctic's activities is Captain Walther Bruns, former commander of Zeppelin airships.

Arktis has a broader scope than the title suggests, for it deals with the Polar Regions as a whole, Antarctic as well as Arctic. The first number (No. 1–2, 1928) shows an interesting range of material. It contains an introduction by Dr. Nansen and by Dr. Albrecht Penck, of the University of Berlin, and as leading papers the following: Explorations in Novaya Zemlya and the Barents Sea Executed by the Institute for the Exploration of the North, by Professor R. Samoilovich of Leningrad; Le monde vivant dans l'Antarctique, by Professor L. Gain, former member of one of the *Pourquoi Pas?* Antarctic expeditions; A Few Remarks on Exploration of Arctic Eurasia, by Dr. I. Tolmatschow (Tolmachev), formerly curator of the Geological Museum of the St. Petersburg Academy of Sciences; Aufgaben, Bemannung und Ausrüstung einer wissenschaftlichen Beobachtungsstation auf dem Treibeis bei 1–2 jähriger Überwinterung in der inneren Arktis, by Dr. H. U. Sverdrup of the *Maud* expedition; Die Ermittlung der Winddaten im Luftfahrzeuge, by Captain J. M. Boykow of Berlin. Dr. L. Breitfuss, of the editorial committee, gives a historical account of the origin and development of the Association; and there is a copy of the constitution and a list of members, among whom Germans and Russians at present predominate.

The Association has produced two previous publications dealing with its field of work. "Das Luftschiff als Forschungsmittel in der Arktis" (1924) contains papers on Arctic meteorology and air navigation. The proceedings of the first general meeting of the Association in Berlin on November 9–13, 1926 (*Ergänzungsheft No. 191 zu Petermanns Mitt.*, 1927) contains a number of valuable papers on the same subjects. To both of these publications and their constituent papers frequent reference is made in the American Geographical Society's *Special Publication No. 7*, "Problems of Polar Research" (1928).

OBITUARY

James White. James White, who died in Ottawa on February 26, 1928, at the age of sixty-five, was justly regarded as the foremost authority on Canadian geographical problems. His long service in various departments of the Civil Service of Canada, during the greater part of which he was prominently identified with the investigation of the Dominion's land areas, boundaries, and natural resources, had given him opportunity to acquire a unique and unrivaled fund of knowledge. As Chief Geographer of the Department of the Interior from 1899 to 1909, he was actively identified with the work of the Alaska Boundary Commission. As Technical Adviser to the Minister of Justice, he assisted and prepared the map evidence in connection with the Labrador Boundary dispute between Canada and Newfoundland in 1926. To his enthusiasm and untiring personal effort was due no small share of the credit for bringing to a successful issue the international and interprovincial negotiations which resulted in the adoption by Canada and the United States of the great conservation measure known as the Migratory Birds Convention.

James White's contributions to the technical literature of Canadian geography are many and important. He was responsible for the publication of an 8-sheet map of Canada, on a scale of 35 miles to one inch. He is the author of "Altitudes in Canada" (1901); "Dictionary of Altitudes in Canada" (1903); and of the revised editions of both these works (1915–16); "Place-Names in Quebec" (1910); "Place-Names, Northern Canada" (1910); "Place-Names, Thousand Islands" (1910); "Boundaries and Treaties" (1913). He is also author of "Atlas of Canada" (1906), a work which he regarded as his chief technical contribution. This important work was revised by J. E. Chalifour, his successor in the office of Chief Geographer, and secured jointly for its co-authors the Roquette gold medal of the Geographical Society of France.

A brief biography of Mr. White has been prepared by Mr. Hugh S. Spence of the Department of Mines, Canada. From a copy, kindly sent to the Society, the above obituary has been made.

GEOGRAPHICAL REVIEWS

GEOGRAPHICAL RECONSTRUCTION OF NORTH AFRICAN HISTORY

E. F. GAUTIER. **L'Islamisation de l'Afrique du Nord: Les siècles obscurs du Maghreb.** 432 pp.; ills., bibliogr., index. Payot, Paris, 1927.

El Maghreb, the "West," is the Arabic term for North Africa. The "obscure centuries" comprise the period between "two Arab invasions, that of the Emirs representing the Caliph, at the end of the seventh century, and that of the Hilalian Bedouins, which began in the middle of the eleventh." The "obscurity" lies in the difficulty of reconstructing and interpreting the history of this period. The Arabic historians whose works serve as our sources had a conception of historical writing very different from that which has prevailed in Europe. For one thing, they were immensely interested in details that to us seem trivial to the highest degree. In the *Roudh el-Qirtas* we are informed of the exact number of bricks used in the arcade of the great mosque at Kairouan; and in connection with the death of the founder of the Almohad dynasty a long paragraph states various conflicting views as to the precise date, whether the 13th or 24th of Ramadan, 424 A. H.; no attempt is made to pass judgment on the ruler's work or even to summarize his achievements. Ibn Khaldun in his famous *Prolegomena* reveals a broader view of the function of the historian, a more synthetic method, and a more mature philosophy of history; but he lived over three hundred years after the close of the "obscure centuries."

Our first thought is: Why has Professor Gautier, a geographer, chosen to study "the obscure centuries of Maghreb"? What business has he to trespass in this domain of the Arabists?

The book is a brilliant answer to these questions. Obscure as they are, the seventh to the eleventh centuries were extremely critical ones in North African history. "The Maghreb underwent the most profoundly intimate change that it is possible to imagine. It was transformed in its religion, in its language, in its very soul. The depth of this transformation suffices to explain the general silence" of the contemporary record. It also explains, but does not altogether justify, the tendency of modern scholars to separate the history of North Africa into "two water-tight compartments. There is no communication between the compartment of classical studies" which have shed much light upon the North Africa of ancient times "and that of the Orientalists" equipped to interpret the Maghreb of the Middle Ages. Were there no connection whatever between the classical North Africa and the Islamic Maghreb this segregation might be excused. The natural environment, however, did not change and the population remained at bottom the same, despite the mighty religious and linguistic movements of the "obscure centuries." In his search for clues to the interpretation of the "obscure centuries," therefore, Gautier found it necessary to look far back into classical times. Indeed, he devotes nearly half of his book to the pre-Islamic period; the work, in reality, is a general outline of the whole history of the Atlas countries.

Professor Gautier tells a long and intricate story by piecing together scraps of evidence drawn from archeology, zoölogy, geography, and history and by reading between the lines of the Arabic authorities. Three or four points will suffice to illustrate his method and point of view.

"Here is the problem that dominates the entire history of the Maghreb, that reappears on every page. In our European national histories the central idea is always the same: by what successive stages has the state, or nation, grown? In the Maghreb, inversely, the central idea is: Through what chain of particular fiascos has the total fiasco been reached?" In other words, throughout North African history no lasting state or nation based on the indigenous population has ever been successfully established. Foreign masters have followed one another in almost uninterrupted succession since the arrival of the Punic founders of Carthage. Disunion shows itself in the mutual hostility of country and city. Professor Gautier likens the city of Fez to an army of occupation quartered in a foreign land from which it draws its provisions but with which, unlike the European capitals, it has no ties of mutual interest or sympathy. One possible explanation of this perpetual disunion may be found in the physical circumstances of North Africa. A chain of plateaus and upland plains extending east and west offers a wonderful avenue for nomadic raiders and conquerors. "Along this artery the poison of conquest has circulated with surprising rapidity through the entire organism, from the Atlantic to the Syrtes or vice versa."

In spite of the reputation of North Africa as one of the granaries of Rome, Professor Gautier believes that the region was very thinly populated at the beginning of the Roman period. Ancient historians frequently mention elephants, although these animals are now extinct. They probably formed part of a relict tropical fauna that has survived profound changes in climate. Their extinction Gautier attributes not to climatic agencies but to a great increase in population under the Romans.

The Maghreb now constitutes part of that great arid belt in the Old World throughout which the population is divided into two mutually hostile groups: nomads and settled folk. This dualism in North Africa first manifested itself as a result of the introduction of the camel, towards the end of the Roman régime. Before the camel was brought from Asia the steppes along the southern fringes of the Atlas and the Sahara were almost uninhabited wildernesses lying beyond the Roman *limes*. The coming of the camels made possible not only the occupation of this frontier region but also the settling of the oases in the heart of the desert. With the adoption by certain of the Berber tribes of a nomadic life based on the camel the cleavage of the North African population into two distinct groups became permanent, and the thread on which almost the entire history of the Maghreb may be strung is the record of the struggles between the nomad camel riders and the settlers. Thus the agriculturist Beranes or Sanhaja of the Middle Ages were the ancestors of the Berber-speaking Kabyles of modern times, and the medieval Botr or Zenata were the progenitors of the modern nomadic "Arabs" of the steppes and desert. While it is true that a certain amount of Arabian blood, as well as Arabic customs and speech, was brought in by the Bedouin tribesmen migrating from northern Arabia with their women and children in the eleventh century, Professor Gautier thinks that the North African nomads of today are essentially Arabicized Berbers.

According to Ibn Khaldun, whose theory reflects the "universal sentiment of the Orient," most powerful among men are the semi-savage nomads who, bound to no particular territory, are free to wander to and fro preying upon settlements. Ibn Khaldun held (as Gautier interprets his views) that "what gives to an Oriental state its area and its bounds is not the nature of the soil or the existence of natural frontiers but the numerical power of the tribe that has furnished the dynasty." This view of the nature of the state, and with it of historical values, is entirely alien to the view that has prevailed in Europe since the time of the early Greeks. The Orientals seem to lack any geographical concept of a nation. They think in terms of race or family or genealogy, rather than in terms of territory. Patriotism is at bottom a geographical sentiment. Its place is taken among the Arabs by *esprit de corps*. This adds a peculiar difficulty to the interpretation of history as recorded by Oriental writers. Professor Gautier's main task, therefore, has been to supply for the Arabic historical sources, and particularly for Ibn Khaldun, the substratum of geography that will render them intelligible to the Occidental mind. It is especially in this skillful use of geography as an aid to the reconstruction of history that the author shows his characteristic originality. Neither a classicist nor an Arabic scholar, Professor Gautier frankly admits that his undertaking is "très particulière, dangereuse, en dehors des méthodes usuelles de l'érudition." This, however, makes the volume all the more stimulating.

Impressions of the Sahara

Angus Buchanan. **Sahara.** xv and 301 pp.; map, ills., index. D. Appleton & Co., New York, 1926. 9 x 6 inches.

The present book, although it centers around Captain Buchanan's great journey across the Sahara from south to north in 1922–1923, is not a narrative of experiences day by day but a group of short essays, stories, and anecdotes interpretative of the great desert and of the life of the people that dwell within it. The keynote is the decay of the Sahara: rocks are crumbling into sand, oases reverting to the wilderness, people either dying out or losing their morale.

Captain Buchanan points out relations between the inhabitants and the land in which they dwell. The Tuaregs of the isolated mountains of Aïr far to the south are a wild and somewhat timid folk, whereas those of the Ergs, or open tracts of sand dune country, are daring raiders. Indeed, the northern Tuaregs as a whole are bolder than their southern brothers. "In the bazaars of In-Salah, Ouargla and Biskra they have learned of the ways of a bold living world." The cleavage between oasis dweller and desert rover is as marked in the Sahara as in Arabia and central Asia (see *Geogr. Rev.*, Vol. 17, 1927, pp. 514–515). The nomadic or semi-nomadic Tuaregs are the dominant folk, the owners and masters of the oases with their gardens and sedentary tillers of the soil. The hard work in the oases is done, for the most part, by negro slaves brought from the south. The truly nomadic Tuaregs occupy widely scattered encampments, in this respect differing from the Bedouins of Arabia who migrate in tribal groups. Buchanan points out that a half dozen huts may be clustered together "where the head of a family is located, then a few other families perhaps miles apart. It is the economic necessity to be within reach of grazing for their live stock which causes this isolated method of camping. Sometimes food is so very scarce that a single family is the sole occupant of a wide area."

Various incidents and aspects of the desert are described: for instance, the sand storms, the sudden torrential downpours of rain that come at rare intervals, a remarkable caravan of no less than 7000 camels that every year crosses a stretch of three hundred miles of sand eastward from Aïr to obtain salt for distribution among the people of the Sudan, an extraordinary town (Fachi) built almost entirely of blocks of rock salt. Buchanan is extremely successful in conveying to the reader the emotional effect which the desert exerts upon the traveler's mind. On the whole he knows how to write so well and with such genuine feeling that we may look with indulgence upon a pardonable overemphasis of the "mysteriousness," the "sadness," and the "mystic" qualities of the Sahara.

The French Colony of the Niger

Maurice Abadie. **La Colonie du Niger.** 466 pp.; maps, ills., bibliogr., index. Société d'Éditions Géographique, Maritimes et Coloniales, Paris, 1927. 10½ x 8 inches.

The Niger Colony, located between latitudes 12° and 24° N., provides the student with an interesting cross section of the Sudan and the Sahara in one of their least-known parts.

This recent volume is a scholarly piece of work; lucid, simply written, concise, yet exhaustively thorough. Above all, it is to be commended for its systematic arrangement and treatment and its excellent illustrations. The book is divided into four parts: Part I, "The Physical Description," contains chapters on geology, hydrography, and climatology; Part II, "The Peoples," includes chapters on the origin and history of the peoples: the black tribes, the white tribes, the languages, institutions, religions, mores, etc.; Part III, "The Political Economy," deals with flora and fauna together with the activities based on them; agriculture, pastoral activities, industry and commerce; Part IV, "Organization and Administration," includes chapters on exploration, conquest and occupation by the French, military and civil organization, communications, etc.

The Colony of the Niger has been called the "Benjamin of the colonies of France," its acquisition and occupation dating only from 1897. The area was at first placed under French military rule, but by degrees it has, after several changes of shape, size, and form of administration, achieved civil rights and government. On October 13, 1922, it was elevated to the rank of a colony, and in 1926 its capital was permanently fixed at Niamey. After many interesting episodes of political geography, its limits have finally been fixed. From Nigeria on the south it extends northward through twelve degrees of latitude to the Fezzan extension of Italian Tripoli. From the Tibesti Highlands and Lake Chad it reaches westward to the Niger River. These frontiers enclose a very heterogeneous area of almost 980,000 square kilometers—nearly twice the size of France.

The colony is readily divisible into three natural zones. The Sudanese zone includes the narrow strip of territory in the south, adjoining the Niger River, the British Colony of Nigeria, and Lake Chad and containing most of the large towns of the colony—Niamey, Gaya, Tahoua, Zinder, Goure, and N'Guigmi. This is the zone of fairly regular annual rainfall, which supports a vegetation of heavy savana grass, browse, and baobab trees. The various Negro peoples here are mainly occupied with agriculture, both irrigated and dry-land culture, with cattle raising, and with some fishing along the streams and permanent lakes.

The Sahelian zone includes the plains to the north of the Sudanese zone together with the highland oases of Aïr, Jado, and Tibesti. The irregular light rains support only low, semidesert grasses, with occasional dum palms and gum trees in the basins. This is the pastoral zone of the colony, but there may be found occasional intensively cultivated and irrigated garden patches. Much hunting is also carried on, for the natives find a ready market for plumes, horns, skins, and hides. The sedentary Tuaregs of Aïr disprove the often asserted statement that nomads are such by choice, for many formerly nomadic Tuaregs now cultivate, irrigate, and manure the valleys of Aïr with all the intelligence, fervor, and love for the earth manifested by the peasantry in France. They have, indeed, won the Colonial Award for achievement in agriculture.

The Saharan zone has extremely rare and irregular rains that support a vegetation of small grasses, thorny growths, and salt bushes. These forms are concentrated in the depressions, leaving much of the surface completely barren. Owing to the apparent desiccation of this part of Africa, the Saharan zone seems to be slowly encroaching on the Sahelian zone. This zone is occupied only by a very sparse population of nomadic Tuaregs, Tibbus, and Arabs, engaged in camel breeding, salt making, and desert commerce.

The census in 1925 showed a population of slightly more than 1,000,000. An exact census is, however, impossible because of the mobility of the tribes. Then, too, the population is subject to violent fluctuations because of epidemics of typhoid, spinal meningitis, etc. One epidemic, lasting from October, 1924, to April, 1925, carried off nearly 100,000 persons. If the high infant mortality, due to poor living quarters and lack of hygiene, be added, it is evident that, notwithstanding the high birth rate, the population is likely to remain practically stationary. This figure of

1,000,000 inhabitants gives an average density of 1 per square kilometer, but this varies from 60 in the Sudanese zone to 8 or 10 in the Sahel and almost 0 in the Sahara.

Another deterrent to the development of the Colony of the Niger is the great distances involved in communication and transportation within the colony itself and in relation to its neighbors. It is 1400 kilometers from Niamey to N'Guigmi, located in the southwest and southeast corners of the colony respectively. In Europe, this is the distance from Paris to Lisbon. By caravan, this trip requires 75 days including stops. From Gaya to Bordai is 1800 kilometers (Paris to Bucharest), which requires 112 days of travel and rest.

Much of the colony's commercial poverty results from the difficulty in exporting its products to outside markets. From Zinder it is 300 kilometers to the end of the railroad in Nigeria, while from Gaya it is 484 kilometers to the end of the railroad in Dahomey. Within the colony itself Niamey might starve while N'Guigmi or Zinder possesses a surplus. The cattle which are able to walk across the border in Nigeria find a constant and easily reached market.

In the words of the author: "The prospects of the future of the Colonie du Niger would appear to be *relatively modest*. Certain regions of the colony, the Niger Valley particularly, while not 'sands where Gallic cock loves to scratch,' are populous and rich enough to be fairly able by the action of our administrators, our industry, our colonists, and our merchants, to undergo a remarkable development and to retrieve the prosperity they formerly enjoyed."

G. T. RENNER

OUR UNITED STATES

A. P. BRIGHAM. **The United States of America: Studies in Physical, Regional, Industrial, and Human Geography.** x and 308 pp.; maps, bibliogrs., index. University of London Press, Ltd., London, 1927. 8s. 6d. 9 x 6 inches.

DOUGLAS W. JOHNSON. **Paysages et problèmes géographiques de la terre américaine.** With preface by Emmanuel de Martonne. 248 pp.; maps, diagrs., ills., bibliogr. Payot, Paris, 1927. 40 fr. 10 x 7 inches.

These two volumes have a somewhat unusual interest in that both deal with aspects of the United States as presented by an American geographer to a foreign audience. Professor Brigham's volume, the wider in scope, is based primarily on a course of lectures given at the University of London in 1924, supplemented from lectures given on other occasions at Oxford University. Professor Johnson's volume is physiographic and includes lectures given in various French universities while he was acting as exchange professor in 1923. By their great gifts of clear and interesting exposition both authors are eminently fitted to the task in hand.

Professor Brigham's book "may be used by schools, reading circles, and by the general reader on either side of the Atlantic." It bears mark of the circumstances of its origin, notably in the last three and most striking of the chapters, with their keynote of the fundamental importance of the Anglo-Saxon tradition in America. In "Traditions and Language" Professor Brigham sounds "a warning against half truths" and against vague and facile generalizations pointing to the "shallowness and failure to reach the heart of things, in most of what we say about geographic influence." "The Statehood Complex" deals with the diversities in the country; their successful combination appears in "National Unity."

"The love of the scientist for the researches to which he has devoted his life, an enthusiasm for the spectacles of nature and the problems of their interpretation animate the descriptions and interpretations of geographic landscapes of the United States with something of the youth and sentiment that is the cachet of the American temperament," says Professor de Martonne of the first part of Professor Johnson's volume, dealing with some typical American landscapes. Accompanied by a representative selection of photographic illustrations this forms an excellent introduction to the subject with which it deals. The second part of the volume takes up various physiographic problems—the rectilinear shore lines of New England and Acadia, the origin of the Gulf of Maine, river capture in the Appalachians, and a chapter in a neglected field—the application of physiographic principles in legal problems.

Soils and Settlement in Wisconsin

A. R. Whitson. **Soils of Wisconsin.** x and 270 pp.; maps, ills., index. *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 68, Soil Ser. No. 49,* Madison, 1927. 9½ x 7 inches.

Joseph Schafer. **Four Wisconsin Counties, Prairie and Forest.** vii and 429 pp.; maps, diagrs., index. (Wisconsin Domesday Book, General Studies, Vol. 2.) State Hist. Soc. of Wisconsin, Madison, 1927. 8½ x 6 inches.

Professor Whitson has prepared a popular report on the soils of Wisconsin, accompanied by a general soil map of the state. Dr. Schafer, superintendent of the State Historical Society, has added another title to his already long list of publications on the local history of Wisconsin. The former is intentionally general and popular, and the latter more pretentious and academic. A critical evaluation of these works is left, respectively, to the soil technologist and the historian; but they contain sections that will be of use to geographers.

Dr. Whitson's report presents the long-awaited soil map of Wisconsin. It is a synthesis of the soil data slowly acquired by the detailed survey of the several counties. While the detailed work is not complete, it has progressed far enough to permit construction of this general map which, reproduced on the scale of ten miles to the inch and in color, is the outstanding contribution of the volume.

The text is divided into eleven chapters. The first three constitute a primer on soils, designed to introduce the reader to the problem of soil classification. A single chapter is devoted to each of the eight major soil provinces. Here the geographer will find some of the fundamental reasons that explain the varying agricultural prosperity from region to region and from farm to farm. The book is illustrated by well-chosen photographs and by several detailed soil maps reproduced in black and white. Some of the latter, because of poor drafting, blur the page rather than illuminate the text.

The work of Dr. Schafer treats of a more restricted area than the report on soil and appears to have been designed more for the scholar than the general reader. This is the third publication in the Domesday Book Series. Volume 1 of the "General Studies," entitled "The History of Agriculture in Wisconsin" (1922), constituted an introduction to "The Domesday Book Town Studies" (1924). The volume under review contrasts Kenosha and Racine counties, characterized by extensive prairies, with Milwaukee and Ozaukee counties, where the land was heavily forested. This circumstance of nature has created an interesting problem in historical geography, to which Dr. Schafer has made a notable contribution. The prairie counties were settled largely by early American stock and more recent immigrants from the British Isles. The forested counties were completely occupied by the influx of German immigrants who came to Wisconsin in large numbers just after 1848.

From the early land entries Dr. Schafer has observed the fear of the first farmers of the open prairies; he has noted that the low marshlands remained in the hands of the government five to ten years longer than did the well-drained areas; and everywhere the proximity to markets was the primary consideration of the pioneers in the choice of farms. Chapter 6, entitled "The Selection of Farm Land," is short but is characterized by its geographic quality. Chapter 8, on the "Political History," will prove a valuable source of information to those interested in the geography of politics. One example will suffice as an illustration. In 1856 the two northern, forested, German-settled counties were intensely Democratic and at the Presidential election returned pluralities in favor of James Buchanan, the Democratic candidate. The two southern, prairie, Yankee-settled counties returned Republican majorities for Frémont.

GUY-HAROLD SMITH

A NEW EDITION OF ANDREE'S GEOGRAPHY OF WORLD TRADE

FRANZ HEIDERICH, HERMANN LEITER, ROBERT SIEGER, edits. **Geographie des Welthandels: Eine wirtschaftsgeographische Erdbeschreibung.** Vol. 1, **Europa.** By 17 authors. xx and 1178 pp.; maps, bibliogr.; Vol. 2, **Die Aussereuropäschen Länder.** By 10 authors. xvi and 1110 pp.; maps, bibliogr. L. W. Seidel & Son, Vienna, 1926, 1927. $9.00, paper; $10.00, linen; $11.50, half leather, per volume. 10 x 7 inches.

In this post-war revision of an encyclopedic work, German thoroughness again exemplifies itself. It constitutes a mine of information to which one may turn for reliable reference.

Volume I, dealing with Europe, is divided into four parts, Central, Western, Southern, and Baltic and Northern. The sections are discussed as regional units, followed by a presentation of the geographic details of each political unit within the region. Each country receives systematic treatment, not according to a set program common to all, but rather according to a sequence of topics which allows of adaptation to the respective countries. The scheme is justifiable, it seems to the reviewer, because economic and commercial statistics are available by countries and exceedingly difficult, if not oftentimes utterly impossible to tabulate, by regions. Again, the interpretation of trade movements is subject to grave error if trade treaties, tariffs, nationalistic antipathies, and other critically influential elements are ignored. Two countries may have surpluses of similar commodities and consequently, in theory, have similar potential markets; but numerous elements, as just indicated, may offer sufficient resistance to the flow of trade in either of the two instances as to induce distinctly different trade channels. Nevertheless, that the authors appreciate the significance of regional conditions upon commerce is frequently illustrated.

In a treatise so inclusive as to subject matter, space limitations preclude an exhaustive discussion of each topic. It does seem, however, that since the text focuses upon commercial geography, more space might have been devoted to the activities of the cities. This could have been accomplished by a reduction in the space allotted to the physiographic and geologic details. The latter seem less essential to an understanding of the commercial development of a region than the cities which represent the climax expression of a country's economic and commercial development. For example, one paragraph is given over to Berlin while several paragraphs, touching upon the physical aspects of its hinterland, appear in the discussion of the North German lowland.

The maps do not approach the excellence for which German cartographers have so long been known. This may be due to the increased post-war cost of production, particularly at a time when strict economy had to be practiced. One cannot avoid noting the persistence of German authors and publishers in indicating upon their maps pre-war German territory. It would seem to be better to eliminate such reference unless the map has this specific purpose as its objective.

The second volume maintains the same high standard set by Volume I and has a similar objective. It aims to direct attention to fundamental changes effected among the non-European countries since the Great War and, after appraising the current situation, to estimate the future commercial destiny of the respective countries. Since the publication of Volume I and the completion of the manuscript for Volume II, two of the guiding spirits of the entire work have passed away—Franz Heiderich and Robert Sieger. The volumes may well stand as worthy monuments to their memory.

Volume II is naturally less intensive in treatment than Volume I. One is impressed, however, by the amount of detail and the accompanying interpretation in view of the necessarily limited acquaintance of the authors with the regions. The volume possesses so much of good that one hesitates to point out defects; yet the reviewer cannot refrain from commenting upon the emphasis given to non-commercial factors, when the title warrants one in anticipating *commerce* as the major theme. On the title page the modifying words, "eine wirtschaftsgeographische Erdbeschreibung" may be intended as more truly representing the authors' objective than the title itself, which clearly focuses attention upon world trade. In this event the presentation is consistent. In any case, the two volumes constitute an excellent survey of the economic conditions over the earth.

EUGENE VAN CLEEF

SOME RECENT EDITIONS OF MARCO POLO

LUIGI FOSCOLO BENEDETTO, edit. **Marco Polo: Il milione.** Prima edizione integrale . . . sotto il patronato della città di Venezia. (Comitato Geografico Nazionale Italiano Pubblicazione No. 3.) ccxxi and 283 pp.; ills., index. Leo S. Olschki, Florence, 1928. 14 x 10 inches.

MANUEL KOMROFF, edit. **The Travels of Marco Polo [the Venetian].** Revised from Marsden's translation and edited with introduction. 2nd edit. xxxii and 370 pp.; index. Boni & Liveright, New York, 1926.

The Travels of Marco Polo the Venetian. With an Introduction by John Masefield. Fully illustrated with twenty drawings in pen and ink by Adrian de Friston and eleven photogravure plates. A reprint of the Marsden-Wright edition. xvii and 461 pp.; maps, ills., index. J. M. Dent & Sons Limited, London and Toronto; E. P. Dutton & Co., New York, 1926.

GEORGE B. PARKS, edit. **The Book of Ser Marco Polo the Venetian Concerning the Kingdoms and Marvels of the East.** (The Modern Readers' Series.) xxxiii and 392 pp.; maps. The Macmillan Company, New York, 1927.

A. J. H. CHARIGNON, edit. **Le livre de Marco Polo,** citoyen de Venise, haut fonctionnaire à la cour de Koubilai-Khan, généralissime des armées mongoles, gouverneur de province, ambassadeur du Grand Khan vers l'Indo-Chine, les Indes, la Perse et les royaumes Chrétiens d'Occident, rédigé en français sous la dictée de l'auteur en 1295 par Rusticien de Pise, revu et corrigé, par Marco Polo lui-même, en 1307, publié par G. Pauthier en 1867, traduit en français moderne et annoté d'après les sources chinoises. Vol. 1. vii and 269 pp. Albert Nachbaur, Pekin, 1924.

Almost as fascinating as the journey of Marco Polo itself is the history of Marco Polo's book since the time when Rustichello of Pisa wrote it down in French while the two men were prisoners in Genoa. The influence of the book on the development of geographical ideas; the direct and indirect effect of the theories derived from it on the progress of exploration; the extent to which Polo's revelation of immense lands and mature civilizations beyond the narrow horizon of the West may have contributed to the broadening of the intellectual outlook of late medieval Europe; the continued popularity of Marco Polo and the place that the study of his travels has taken in modern scholarship—the mere statement of these problems will suggest some of the many paths that allure the historian of the so-called "Milione."

The central core of this history is the record of the text. We do not possess the original version as written by Rustichello. In the long process of copying, recopying, and translating by medieval scribes portions were dropped out or changed, and additions were made. The relative value of the existing manuscripts and early printed versions, therefore, has become a subject of dispute among students, and the principal modern editions are based upon widely differing texts. Of the recent editions listed above all but that of Benedetto are essentially reprints of well-known texts of nineteenth century scholars.

Komroff's edition and that published by Dent—like the edition in Everyman's Library—make use of Thomas Wright's revision (1854) of William Marsden's English translation (1818) of the Latin version published by G. B. Ramusio in the middle of the sixteenth century. The Dent edition, although attractively illustrated and containing an introduction by John Masefield, is merely a reprint of the Marsden-Wright translation; the footnotes being the same as those of the 1854 edition, the reader of this edition will gain no idea of the important work done by later scholars—such as Pauthier, Yule, and Cordier—in commenting upon Polo's work. Komroff omits footnotes; he occasionally corrects Marsden's translation in order to bring the meaning into accord with that of Yule's edition; and he numbers the chapters as Yule numbers them. Parks's text is based on Sir Henry Yule's famous English translation. The elaborate commentary, in which Yule and Henri Cordier both draw upon their vast store of knowledge of the medieval and modern Orient, is omitted, as the book, like Komroff's version, is intended for the general reader.

Charignon's edition is a translation into modern French of the old French text published by Pauthier in 1867; in the notes the editor quotes extensively from both Yule's and Pauthier's commentaries and also adds the results of his own studies of the Chinese sources.

Benedetto's work far surpasses in significance any of the other four volumes under review. The introduction (221 large pages) gives an elaborate analysis of the entire textual question based on the examination of over 130 manuscripts. This introduction is followed by the first genuinely critical text of the "Milione" that has ever been printed, the first text constructed in accordance with the high standards of modern textual criticism. There is no commentary, except in so far as it relates to the text.

Benedetto's work must serve as the foundation for all serious future studies of Marco Polo. For many years the impression has prevailed that Yule and Cordier did practically all there was to be done in this field. Benedetto shows the falsity of this idea. Not only has he brought to light new manuscripts containing data of unquestioned Polian provenance, but through comparative investigations he has been able to estimate the relative authenticity of the different parts of hitherto well-known texts. The danger no longer exists, as in the past, of the scholar's wasting "treasures of erudition in illustrating, not the thought of Marco Polo, but the errors of his copyists." As a result of Benedetto's work the need now arises for a wholly new English translation.

MAN IN "THE CORRIDORS OF TIME"

HAROLD PEAKE AND H. J. FLEURE. **Apes and Men.** vi and 138 pp.; maps, diagrs., ills., bibliogrs., index (The Corridors of Time, I). **Hunters and Artists.** vi and 154 pp.; maps, ills., bibliogr., index (The Corridors of Time, II). **Peasants and Potters.** v and 152 pp.; maps, ills., bibliogr., index (The Corridors of Time, III). **Priests and Kings.** 208 pp.; maps, ills., bibliogr., index (The Corridors of Time, IV). Yale University Press, New Haven; Oxford University Press, London, 1927. $2.00 per volume. 8 x 5½ inches.

Whenever one turns to the human problem one begins to think in terms of geography and time. One knows where to look for reference to an outline of the land base and the environmental settings to human habitats; but when it comes to a matter of sequence in time, or an outline of man's career upon this land base, one may well be at a loss where to look for a summary statement. In theory, archeology is prehistoric history and should be continuous with it; but, for reasons not necessary to state, archeology and history are treated separately, and their coördination has scarcely passed beyond the controversial stage. This need for coördination our authors have sought to meet in their "Corridors of Time." As they see it, the interpretation of human culture is one of the most important problems of our time and they believe that the approach lies in chronology, or the extension of the historical point of view far back beyond the origin of writing. So they have set out to present in concise form the present state of geographical and historic research for the period between man's first appearance and 2500 B.C. Each volume is accompanied by chronological tables, diagrams, and sketch maps executed with a view toward ready accessibility and clarity. Four other volumes, to be published shortly, will deal with the spread of civilization and especially with developments in Western Europe.

Quite appropriately, the first volume "Apes and Men," begins with a review of man's beliefs concerning his origin, from which it appears that even savages are moved to speculate upon this problem. After this introduction comes a brief chapter on the geological history of the earth, the appearance of life, and the successive climatic changes in their relation to man. Then follow chapters on the Descent of Man, the Ice Age, Early Tools, and Early Types of Man.

The second volume, "Hunters and Artists," deals with paleolithic man, giving special attention to the geographical background, as the Retreat of the Ice; Changes in the Coast Line; Tundra, Steppe, and Forest. Then follows a sketch of paleolithic life, particularly well done, covering not only France but Spain and other outlying regions. One useful feature of this volume is the table of the most important skulls and stations, place of the find, a few of the outstanding anatomical features, etc., more than eighty in all. As usual, the volume closes with a chronological summary and the following interesting interpretation:

"Thus from a free and open hunting life the people of northwestern Europe had been reduced to the status of the poorest food-collectors . . . The closing in of the oak forest, completing the destruction of their hunting-grounds, was the main cause of this degeneration, and it seems likely that our predecessors would have remained for ever in this backward state, had not movements from the east brought a fresh impetus into their lives" (p. 150).

In fact, these few lines breathe the spirit of the whole work, the authors conceiving the human problem after the fashion of Thompson's "web of life" but extending the idea to include all changes, climatic as well as organic.

The third volume, "Peasants and Potters," is like the key to an arch—what preceded seems preparatory to it, and what follows is sustained by it. The ice ages were over, and the glacial wastes of Europe and Asia were covered with forests. The people, the authors believe, then settled down to a routine of food gathering, their only achievements being the taming of the dog and the acquisition of pottery; but otherwise the savage communities of Europe and northern Asia stagnated throughout this period. Yet in the valley of the Nile and the Fertile Crescent of the east the story was otherwise. Here one of the most significant developments was the raising of wheat and similar grains, regarded by the authors as the most important factor in the economic basis to the events to be heralded in the next volume. Closely linked with this is the development of pottery, the dairy, and the herds. The chief facts and problems connected with these developments are fully discussed. When we note that here appear in domestication the cow, goat, sheep, ass, horse, camel, and dog, we see how little remained for the world to add. It was, the authors think, this increased ability to feed himself, care for his children, and transport his equipment that accounts for the great advance. It is considered natural that these great achievements should influence the fringe of ruder peoples, especially on the north and west;

and we are shown the beginnings of what are to be great Mediterranean developments, culminating in Greece and in Rome. Mesopotamia and Egypt, however, are the great centers; and the chronological development of these centers is well worked out in a chart. At this time, also, the nations and peoples we still recognize are taking form, all of which is sketched in a few pages, followed by a chronological summary of the whole period. The point of view seems to be that civilization was the work of many communities. Not in Egypt alone, nor in Mesopotamia, are we to look for all that now makes up civilization; but by give and take, and with varying fortunes, thousands of communities scattered over a wide radius made this the joint contribution to the present.

"Priests and Kings" is the title chosen for the fourth volume, and for the most part the period dealt with lies at the dawn of history—3500 to 2500 B.C. We are told that this was "a remarkable millennium," marked by the unification that resulted in great empires in Egypt and Mesopotamia, with important developments in Crete, the Aegean, the Danube basin, and the fertile lands just north of the Black Sea; by the development of writing, stone and brick architecture, the use of metals, and an organized priesthood. Writing puts a different aspect upon chronology, since the record now gives us lists of kings and also an increasing number of dates. Another basic matter is that the climatic changes have been less, much less, giving a fairly stabilized epoch. It is not overlooked that local changes may have occurred to disturb the even rôle of culture, as not a few scholars assert; but the period as a whole seems to have been a kind of "hotbed" for the germination and propagation of cultures, for the organization of small tribal units into national bodies. The main section of the work deals with Sumer and Akkad, the old kingdom of Egypt, the Minoan, and the Aegean world. The development of metals is regarded as one of the outstanding achievements, if not the one great culture achievement; but agriculture and the sedentary arts were working their way into the valley of the Danube and what is now southern Russia, which the authors consider as laying the foundation to modern peasant life in Europe. The volume closes with a brief summary chapter on the races of man.

The series is well conceived, contains a wealth of fact, and will prove a useful set of handbooks for geographers, anthropologists, and historians.

CLARK WISSLER

THE HYDROGRAPHY OF THE NORTH AND BALTIC SEAS

Atlas für Temperatur, Salzgehalt und Dichte der Nordsee und Ostsee. 3 pp. of text, 48 pls. of maps and diagrs., bibliogr. Deutsche Seewarte, Hamburg, 1927. M. 15. 16 x 13 inches.

The North Sea and the Baltic wash the shores of some half dozen countries of northwestern Europe, each of which has carried out hydrographic work of various kinds in these waters. As a result, a considerable mass of information covering different areas is at hand. This information, however, is embodied in all sorts of publications and in a number of different languages. A comprehensive summary unifying this scattered information was much needed.

This feature gives especial value to the atlas of the Deutsche Seewarte. Of the 48 plates constituting the atlas the first is a chart on the scale of approximately 1:5,000,000 showing the depths in the North Sea, the Baltic, and their tributary arms. The following plates give the temperatures, salinities, and densities of these waters for the beginning of each of the months of February, May, August, and November. For each of these months charts on the scale of approximately 1:5,000,000 give the conditions at the surface and at the bottom, while smaller-scale charts represent the conditions at the 10-meter depth and at each 20-meter depth to 100 meters. There are also shown for each of these months the hydrographic conditions on four principal profiles through these waters. Obviously the scale of the charts is too small to show the hydrographic conditions close to shore; and in the introductory remarks Prof. G. Schott and Dr. A. Schumacher, under whose direction the atlas was prepared, call attention to this.

For arriving at an understanding of the involved hydrographic features of the areas represented the atlas will fill a long-felt need. The notation "no observations" which appears in certain areas on a number of the charts directs attention to the need for such observations in these areas, and it is reasonable to expect that it will stimulate efforts in that direction. At the same time the atlas brings out the need for a discussion of the variations in the features represented—a desideratum which it is hoped may not long be wanting.

H. A. Marmer

CORRESPONDENCE

The Labrador Coast

The *Geographical Review* for October, 1927, contains two very interesting articles on Labrador, "Notes on the Torngat Region of Northern Labrador," by Robert H. Woodworth, and "The Labrador Boundary Decision," by Sir Patrick T. McGrath, on which I should like to make some comments.

The first paper is an excellent and beautifully illustrated account of exploration in the Torngat region; but why should the accompanying map call the lake just inland from the end of Nachvak Fiord "Chance Lake"? On maps published by Daly and myself the same lake has the Eskimo name "Tessersoak"; and it seems better when possible to retain the native name. The name "Chance" might be given to a lake a few miles to the northwest, as shown on Woodworth's map.

Another point is in regard to the height of the Four Peaks north of Komaktorvik Fiord. I had a good view of that part of the Torngats from summits a few miles to the south and could not distinguish four special peaks rising above the rest. Instead there was a jumble of domes and peaks reaching about the same height. After a number of climbs near Komaktorvik and Nachvak fiords, one reaching 5500 feet, I very much doubt that any point in the Torngats reaches 6000 feet and feel certain that none rise to 7000 feet.

In Sir Patrick's paper attention is called to a matter which should interest all geographers, since the decision of the Judicial Committee of the Privy Council, the highest tribunal in the British Empire, includes a definition of the term "coast," or "coasts," which, it seems to me, is rather hard to accept. They decide that "coast" is equivalent to "watershed." In the particular case of the boundary between Newfoundland and Quebec the watershed is so placed as to include all the mountains of the region within the "coast." In fact the western edge of this "coast" is drawn far down the slope of the table-land toward Ungava Bay. The Torngats and other mountains toward the south have elevations running from 5500 feet to 2700 feet, while the inner edge of the "coast," according to the decision, runs only from 1750 feet toward the south of the watershed to less than 1000 feet toward the north at points inland from the Nachvak and Komaktorvik valleys. If this decision is to rule in geography very few countries will have any interior—they will consist solely of coasts.

The watershed in the heart of Labrador will make an extraordinarily troublesome boundary, since the parting of the waters on the peneplain is most intricate. Low, who made the only serviceable map of the region, speaking of the divide between Hamilton River and the St. Lawrence, says that "the watershed . . . is extremely sinuous and almost impossible to trace or define."[1]

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[1] *Canada Geol. Survey, Ann. Rept.*, Vol. 8 (N. S.), 1895, subreport L, p. 129.

It is about the worst possible boundary and is certain to make trouble in the future. Low mapped iron-bearing Animikie rocks just on the Labrador watershed, and already two parties of Canadian prospectors have visited parts of the band, though without finding ore of workable grade. It is not improbable that deposits of gold or silver or copper will be found near the watershed, as they have been found in many other parts of the Archean Shield. If so, there will be a rush to the region by airplane and canoe, and this intangible boundary of muskegs and lakes and interlocking streamlets will suddenly become a matter of very lively controversy.

In practically unknown regions an astronomic boundary, whose position can always be exactly fixed, is much the best, such as the northern boundary between Alaska and Yukon Territory. In Labrador a boundary following the meridian of 63°, running north from latitude 52° to latitude 57°, then jogging west to longitude 65°, and finally north to the sea would have been far better. Perhaps, however, one would choose the highest Pleistocene beach, rising from 225 to about 500 feet above present sea level on different parts of the coast. This would run inland a few miles at all the bays and would provide the gently sloping or level ground for fish drying stages or summer dwellings and storehouses, which are all that the Newfoundland fisherman ever desired on the bleak Labrador coast.

I wish to call attention to another point. It is generally held that discovery and exploration of unoccupied territory give a valid claim to ownership; yet there is no mention in the Report of the Privy Council of the fact that, except for some excursions by American citizens in the region of Hamilton River and along the coast, the whole of the exploration and mapping of the region in dispute has been done by Canadian geologists and explorers. No Newfoundlander ever ventured far into the interior.

I am not aware whether this point was presented to their lordships; but from the wording of the report one may conclude that the decision was made on a purely legal view of the documents with no reference to practical considerations.

The map accompanying the Report of the Tribunal and showing the boundary is one of the worst published in recent years and is very incorrect in the northern portion with which I am familiar. For instance, Nachvak Fiord is shown as about eight miles wide instead of two, and Tessersoak Lake and Nachvak River are not indicated at all; while Komaktorvik Fiord, with its river and lake inland, is not even suggested. The two rivers flowing into these fiords, with their tributaries, will determine the boundary for more than fifty miles, and they are shown on maps published by the Geological Survey of Canada; but the cartographers for the Privy Council were not aware of their existence.

A. P. Coleman

Royal Ontario Museum
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Index to the Bulletin of the American Geographical Society, 1852–1915. By Arthur A. Brooks. With an historical and bibliographical note and a table showing the arrangement and composition of the series. xi and 242 pp. $2.00.

The Geographical Review. Vols. 1–18, 1916 to date. Successor to the *Bulletin of the American Geographical Society.* Monthly, 1916–1920; quarterly since 1921. Monthly numbers, 50 cents; quarterly numbers, $1.25; unbound volumes, 1916–1920 (two a year), $2.50; from 1921 (one a year), $5.00.

Index to the Geographical Review, Vols. I–XV, 1916–1925. By Arthur A. Brooks. iii and 432 pp. 1926. $4.50, unbound; $5.25, bound.

China: Land of Famine. By Walter H. Mallory. With a Foreword by Dr. John H. Finley, President of the American Geographical Society. With 91 photographs and 12 maps. xvi and 199 pp. *Special Publication No. 6.* 1926. $4.00.

Problems of Polar Research. By 31 Authors. 479 pp.; 96 maps, diagrams, and photographs. *Special Publication No. 7,* 1928. $5.00.

The Geography of the Polar Regions. By Otto Nordenskjöld and Ludwig Mecking. 370 pp.; 135 maps, diagrams, and photographs. *Special Publication No. 8,* 1928. $4.00.

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The Vegetation and Soils of Africa. By H. L. Shantz and C. F. Marbut. With a section on land classification by the joint authors and a note on a rainfall map of Africa by J. B. Kincer. With 1 text map, 49 photographs, and a separate case of two maps (in color) 1:10,000,000, each with inset, 1:25,000,000, showing vegetation (on inset: soils) and land classification (on inset: annual rainfall). x and 263 pp. *Research Series No. 13,* 1923. $5.00.

The Geographical Lore of the Time of the Crusades: A Study in the History of Medieval Science and Tradition in Western Europe. By JOHN KIRTLAND WRIGHT. With 10 maps, mainly facsimiles of medieval maps, and 2 diagrams. xxi and 563 pp. *Research Series No. 15*, 1924. $5.00.

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Oriental Explorations and Studies, Nos. 1–4. By ALOIS MUSIL. No. 1. **The Northern Hegaz: A Topographical Itinerary.** xii and 374 pp. 1926. $7.00; No. 2. **Arabia Deserta: A Topographical Itinerary.** xvii and 631 pp. 1927. $8.00; No. 3. **The Middle Euphrates: A Topographical Itinerary.** xv and 426 pp. 1927. $8.00; No. 4. **Palmyrena: A Topographical Itinerary.** xiv and 367 pp. 1928. $7.00. Each volume fully illustrated with photographs, maps, drawings, and plans.

Geography of the Central Andes: A Handbook to Accompany the La Paz Sheet of the Map of South America on the Millionth Scale. By ALAN G. OGILVIE. With an introduction by ISAIAH BOWMAN. With 2 maps in color and 41 diagrams and photographs. 240 pp. *Map of Hispanic America, Publication No. 1*, 1922. $3.00 (if purchased with the La Paz map, $2.00).

Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, North H-11, **Baja California Norte**; North G-12, **Baja California Sur**; North F-16, **Yucatán**; North F-18, **Santiago de Cuba**; North E-18, **Kingston-Port-au-Prince**; North E-19, **Santo Domingo-San Juan**; North E-20, **Lesser Antilles North**; North D-20, **Lesser Antilles South**; North C-17, **Panamá**; North A-17, **Río Mira-Islas Galápagos**; South C-19, **Acre**; South D-19, **Puno-Río Beni**; South E-19, **La Paz**; South E-20, **Sucre**; South F-19, **Iquique**; South F-20, **Río Pilcomayo**; South G-19, **Atacama**; South I-18, **Canquenes y Islas Esporádicas**; South L-18, **Península de Tai-Tao**; South M-18, **Isla Wellington-Lago Argentino.** $2.00 each sheet.

Mapa de la Republica de Panamá, 1:500,000 [7.89 miles to 1 inch] compiled from over 100 original surveys, many of them unpublished. Printed in five colors. Follows in general the scheme of the International Map of the World on the Millionth Scale, but hypsometric tints have been omitted and the provinces shown in color instead. Accepted as official map by the government of Panama. 33 x 63 inches. 1926. $3.00.

The Leardo Map of the World of 1452 or 1453. Colored reproduction (measuring 28⅝ x 23½ inches, printed on sheet 35 x 30 inches) of map in the collections of the American Geographical Society. Accompanied by volume containing text by JOHN KIRTLAND WRIGHT describing the original map and a note by A. B. HOEN on the method of reproduction, with 3 photographs and 7 maps, viii and 90 pp. *Library Series No. 4.* 1927. $15.00 ($2.00 for text alone).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

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THE FLIGHT FROM ALASKA TO SPITSBERGEN, 1928, AND THE PRELIMINARY FLIGHTS OF 1926 AND 1927

Captain Sir Hubert Wilkins

WHEN the Detroit Arctic Expedition of 1926 was first planned there were two large areas, one in the Arctic and one in the Antarctic, still to be explored.[1] The main object of the Detroit Arctic Expedition was exploration in the unknown Arctic. There were other things of interest on which it was also hoped to shed light, more particularly on meteorological conditions in the area and the possibility of the establishment of meteorological stations there; and on aerial transportation in the Arctic.

Through a study of universal meteorological conditions we can hope to provide information of extreme value to primary producers and so help to feed the ever increasing population of the world, and we can at the same time and from the same source aid travelers who in the near future will be taking advantage of the whole world's surface—of latitudes far above the polar circles and of altitudes far above the mountains and the seas. From the beginning of history mankind has been concerned with and greatly influenced by the weather; but it is only now, since the development of modern science has brought about long distance communication by means of wireless and speedy transportation by means of aircraft, that we can expect to carry out and make use of observations which might give us some information as to the mechanism of the weather. If a knowledge of the weather system can be gained, then we can on long distance flights by aircraft expect to take full advantage of natural conditions instead of being, as we are now, at their mercy.

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[1] A brief statement of the expeditions and their objective is given in "Captain Wilkins' Arctic Expeditions, 1926–1928," *Geogr. Rev.*, Vol. 18, 1928, pp. 489–494. The detailed reports of the expeditions and the original field records are deposited with the American Geographical Society.

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SUITABILITY OF AIRPLANES FOR ARCTIC TRANSPORTATION[2]

The question of suitable landing fields in the Arctic is of the first importance. Airplanes even now are ill prepared for taking off the ground and for coming to rest. In most instances fields must be prepared before they are fit for landing places. But along the lagoon-fringed shore of the Alaskan Arctic coast there are hundreds of miles of ice as flat as a table. Throughout much of the year this ice is covered with snow not more than ten or twelve inches deep. I had gained considerable experience with aircraft during the years 1910–1913, and when I was with Stefansson in the Arctic during 1913–1916 I was able to look at the ice surfaces from a pilot's point of view; day after day as I traveled along the Arctic shores and over the sea ice, my attention was drawn to many suitable landing fields. In summing up the conditions it was my estimate that near the Alaskan shore in late winter and early spring, both near the land and on the sea ice, emergency landing fields could be found within a radius of twenty miles from any point. I believed that more suitable emergency fields would be found on the Arctic pack ice at the right season than in most unsettled country districts.

Many engineers doubted that engines would function in the low temperatures experienced in high latitudes. From personal experience with internal combustion engines used on the Stefansson expedition, I knew that gasoline motors would not function if exposed to such temperatures as would be encountered during an Arctic winter or spring. But it required little inventiveness to arrange a safe convenience for heating the air before it entered the carburetor, and it would be an easy matter by means of suitable cowling to insulate an airplane engine from the cold. The question as to whether the wings and the fuselage of the plane would withstand polar conditions had been settled by the evidence collected during Sir Douglas Mawson's expedition to the Antarctic in 1912 when he used an airplane fuselage in temperature well below zero.

The apparent difficulties with regard to equipment for polar flying seemed to me to be solved. It was only a question of adaptation by human hand. Some of us have been privileged to experience polar conditions, and we know how really comfortable they can be; but this knowledge was gained only by experiencing in our early ignorance real hardships and by learning gradually the ways of comfort. We knew from our own experience that the job of flying the Arctic could be done. We might not do it successfully, because any man and any machine is prone to fail; but that would not alter the fact that some day some one would prove to the satisfaction of the world that polar flying is not an impossibility.

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[2] See also the author's contribution "Polar Exploration by Airplane" in Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No. 7*, New York, 1928.

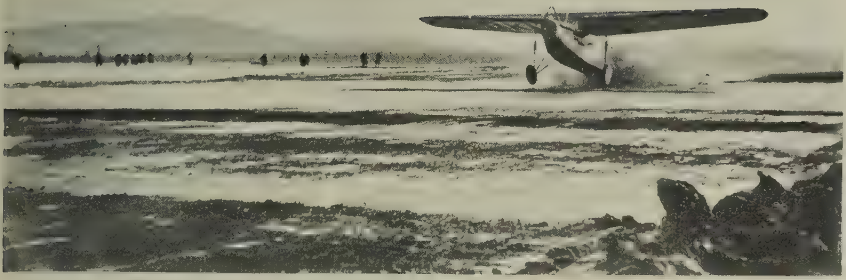

FIG. 1

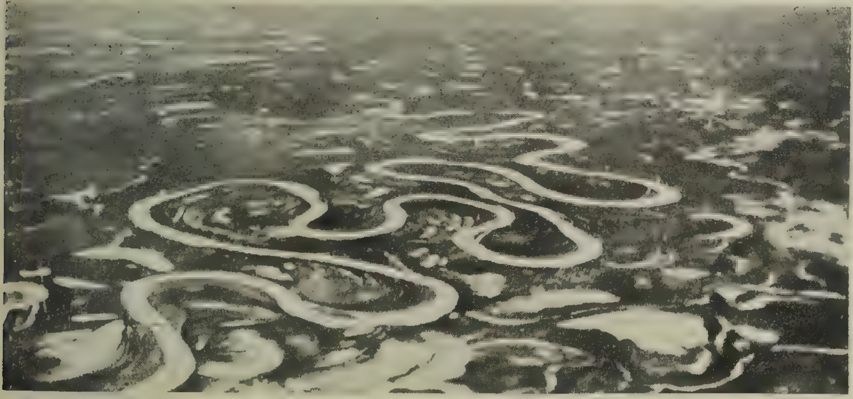

FIG. 2

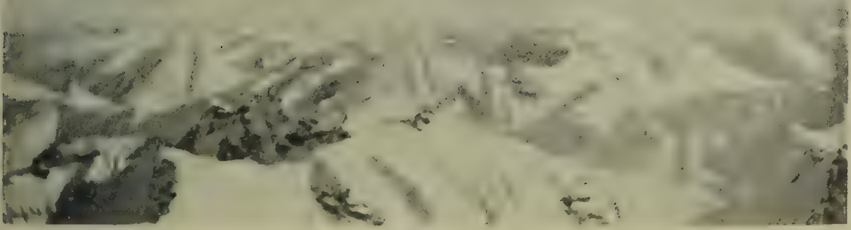

FIG. 3

FIG. 1—Taking off the Fairbanks runway on the first trip to Point Barrow.

FIG. 2—The Koyukuk River (see Fig. 4). In the distance it joins the Yukon.

FIG. 3—Looking over the Endicott Mountains to the low flat tundra that extends to the Arctic Sea.

The Flights of 1926

In order to investigate the unexplored area northward of Barrow, Alaska, we planned to take our airplanes—a three-engined and a single-engined Fokker—to Fairbanks, the most northerly point in Alaska to be reached by ordinary means of transportation, and then fly with our supplies to Point Barrow, the most northwesterly point of the American continent and within fifty miles of the unexplored area. From Barrow we proposed to make several flights over the Arctic Sea and, if our experience should make it seem possible and safe, to undertake a flight from Barrow to Spitsbergen.

Trial flights at Fairbanks resulted in accidents to both planes. The single-engined plane, however, was ready three weeks later; and on March 31 with Eielson as pilot the writer as navigator flew from Fairbanks toward Barrow, following a compass course. We crossed the north end of the Sawtooth range and passed over the Yukon Valley which was covered by fog. We approached the Endicott Mountains—which here had not been surveyed at all—at an altitude of 6000 feet. The range was bathed in sunshine, and we saw that the mountain peaks were higher than we were. We climbed to 9000 feet with difficulty. That seemed to be as high as the loaded plane would go, but the mountain peaks were still higher. We threaded our way through them.

North of the mountains the land was covered with cloud 4000 feet thick. Conditions were confusing because a high following wind had brought us to the Arctic slopes in much less time than we had anticipated. My observations for ground speed and drift gave some indication of our great speed. We continued our compass course above the fog for 200 miles and then saw beneath us ice, of whose character from an altitude of 5000 feet I was not certain. It might have been lagoon or lake ice or the ice of the Arctic Sea. We flew on, keeping the same compass course. In a few minutes we were in clear atmosphere and over unmistakable Arctic Sea ice. Undoubtedly we had passed Point Barrow. Finding ourselves in this position we decided to go still farther north and do some useful exploration before returning to Barrow. We continued on in clear conditions for 150 miles, then reversed our course and flew back to the edge of the clouded area. We flew southeast for 50 miles, to be certain we were over land, then coming down as low as possible, flew due west to the cliff formation which we knew fringed the coast southwest of Point Barrow. We sighted the "cut bank" and then swung sharply to follow it, in less than twenty minutes reaching the village of Barrow, which could not be seen that day from more than a mile distant.

We landed on the Barrow lagoon in a wind of about 40 miles an hour, in a temperature of 30° below zero Fahrenheit. It had been colder earlier in the day. The wheels of the machine hardly marked the snow. The surface of the lagoon that day was as good and hard as any turfed landing field. A storm held us at Barrow for five days, during which time much soft snow fell, blanketing the surface. By the time we could leave, the soft snow on top had so warmed the hard lagoon surface that the wheels cut through to the solid ice. However, after several attempts we took the air and headed for Fairbanks. We maintained our course until within a hundred miles of our destination. The sky was overcast; and, failing to recognize the country, we decided to return to the Yukon River, to locate some unmistakable point. The first such position was Circle City, where the river surface near by offered an excellent landing field. To avoid any shortage of gasoline and oil on the way we descended and replenished our tanks, returning to our base the next day.

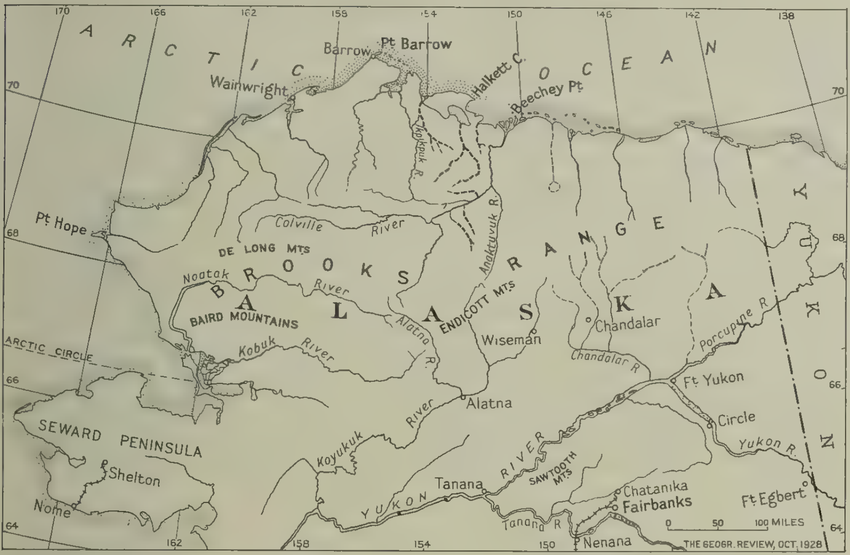

FIG. 4—Map of northern Alaska, scale 1 : 12,000,000. The courses of rivers shown by heavy dashed lines were sketched by Captain Wilkins from the air.

Two days later we made a second trip to Barrow. Cloud conditions were almost the same as before. The hundred-miles-wide Yukon Valley was blanketed with fog; the sky was clear over the mountains, and clouds 4000 feet high extended over the plains to the edge of the Arctic pack ice. The immediate vicinity of Barrow village was clear. After a few hours rest we left Point Barrow on the return trip. Just before we started my mitten caught in the spokes of the wheel, and my arm was drawn between the wheel and the stanchion of the landing gear. The small bone of my right arm was broken near the wrist in two places. Because of this it was advisable, in case of engine trouble, that we follow a course offering the maximum of good landing grounds and facilities of travel to habitations. I shaped our course slightly to the west of a direct route to Fairbanks to strike the Tanana River that we might follow it to our base. Bad weather kept us at Fairbanks for a few days, and then we made a third trip to Barrow.

By this time spring was well advanced. The landing field at Fairbanks was a puddle. Rain and sleet fell at frequent intervals upon the foothills. The Endicott Mountains were, for the greater part of the day, cloud-covered. As we approached them we could see that the clouds were too high to pass over. They drooped over the mountain tops to within 2000 feet of sea level. We circled several times in an endeavor to get through, only to meet thick clouds or monster peaks. It was as easy to fly in one direction as another; and so we decided to stick to our course, climbing as much as possible. The machine with the heavy load, however, could not climb high enough to clear the mountain peaks. I believed that if the load were piled toward the nose of the machine it might help us, and so I carried the cases of gasoline to the forward part. I then had time to look out of the window and at that moment saw a steep high peak just ahead. I shouted to Eielson to keep to the left, but he was avoiding a peak on his side. There was barely room for the wings to pass between them, and it looked as if we were not high enough to clear the snow. I was watching the wing tip and was too anxious perhaps to notice a slight shock, but on looking down I saw the wheel of the machine spinning as fast as if we had just left the ground. Fortunately the valley we entered in such a manner led to the Arctic plains below. Cloud conditions over the tundra were similar to those of our first experience: we rarely caught a glimpse of the ground beneath us.

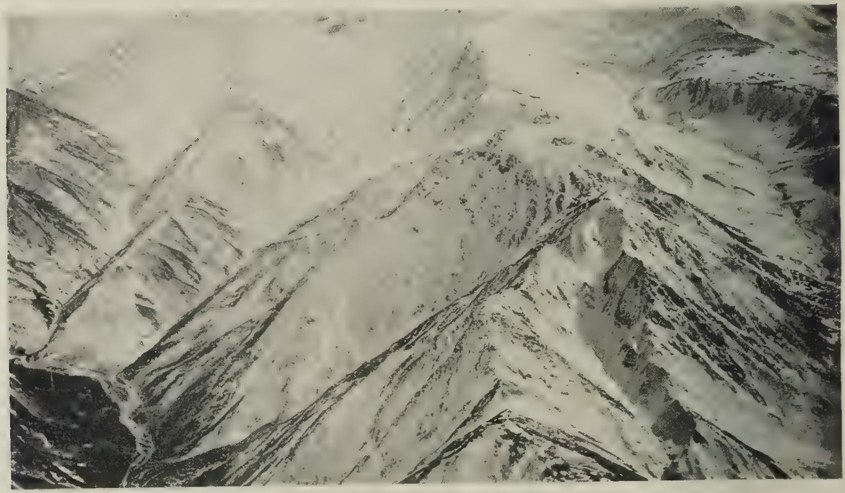

FIG. 5—Looking eastward along the Endicott Mountains from above the Anuktuvuk River.

Unsettled weather continued. We made two attempts to return to Fairbanks, on both of which we were forced back. Once, because a storm had developed at Barrow in our absence, we had great difficulty in reaching the village. It was necessary to fly out far over the Arctic Sea and then come down to within a hundred feet of the rough sea ice and check our course by the direction of the snowdrifts until we reached the coast and then, with only a few feet of altitude, follow the coast to the village. An accident to the propeller delayed us further. It was temporarily repaired, and finally we succeeded in getting off and reached Fairbanks without incident. The damage done to the propellor prohibited use of the smaller plane again, and thus we had only one hope left—the three-engined machine, which the two expert army pilots, Major Lanphier and Sergeant Wisely, declared unserviceable. I decided to give them the opportunity to revise their reports.

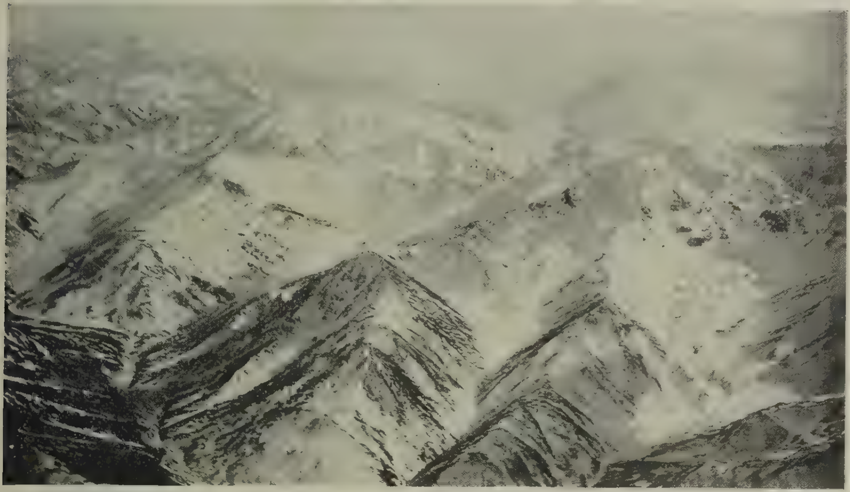

FIG. 6—The view northward from the head of Wild Creek, a headwaters stream of the Koyukuk.

The season was late, too late in fact for us to be sure that we could do anything of value. The snow had cleared from the Yukon Valley, and the rains had melted most of the snow from the mountains. Thick clouds hung over the Endicott peaks. We left Fairbanks with a load of over 7000 pounds in the machine. We steadily climbed to 11,000 feet and after a battle of two hours flew over the clouded top of the range. We had then to face a two-hundred-mile flight on a compass course. It was an ordinary thing to me because we had done so on each previous trip. But neither Major Lanphier nor Sergeant Wisely had made the trip before. The grayness on the horizon gave no more vision than if we had been enveloped in a mask of gray silk. It looked ominous to them. Suddenly we dived from 11,000 feet until we nearly reached the ground. The machine seemed to be out of control, but the pilot flattened it out. He had decided to try to fly beneath the clouds a few feet above the snow instead of over them. But the fog was too thick. From a height of 500 feet we could see a few black objects on the surface, but we could not have kept direction; and so it was necessary to turn back, fly out of the cloud, and climb again above it. We again set a compass course for Barrow and as expected, after flying some two hundred miles, came to a safe landing on the lagoon and taxied to a suitable place for another start. But spring conditions had already set in at Barrow. The fog which had hitherto cloaked only the tundra was creeping out over the Arctic Sea ice, making it unlikely that we could serve any useful purpose by flying northward.

Hoping that we might at least have one clear day, we waited for a period of two weeks; but the fog did not lift. With great difficulty we rose from the lagoon and flew back through the clouds and bad weather to Fairbanks.

The Flights of 1927

While in 1926 we had done a great deal to confirm our confidence in the possibility of successful Arctic flying and had gained considerable experience, we had explored very little of the Arctic Sea ice. The Amundsen-Ellsworth-Nobile flight in the dirigible north from Spitsbergen to Alaska was popularly believed to have eliminated the possibility of discovering land between Barrow and the pole; but, while these men skillfully flew for a great distance over cloud and reached their destination, the conditions beneath the clouds could not everywhere be observed. Perhaps there was land, perhaps not. But even supposing the trip of the *Norge* had cleared the area north of Point Barrow, there were still great areas to the northwest and northeast to be explored. To investigate these areas was my original plan. It was to include at least two flights of about 600 miles from Barrow to the northwest and northeast and, if land was not found, a descent onto the ice to take soundings. When that work was done the advisability of making a nonstop flight to Spitsbergen would be considered.

It was intended that the entire personnel of the expedition should go to Barrow at the same time with the three planes—two Stinsons and the reconditioned Fokker. Everything was prepared, but the night before the attempt soft snow fell and covered the runway. The Fokker failed to leave the ground and in taxiing back for a second try ran into a snow-filled gutter and broke one of the skis. I decided to leave it at Fairbanks until we had completed the short flights into the Arctic. The two Stinson machines made nonstop flights to the Arctic coast. One machine was made ready for a flight over the Arctic Sea four days after our arrival. With Eielson as pilot and

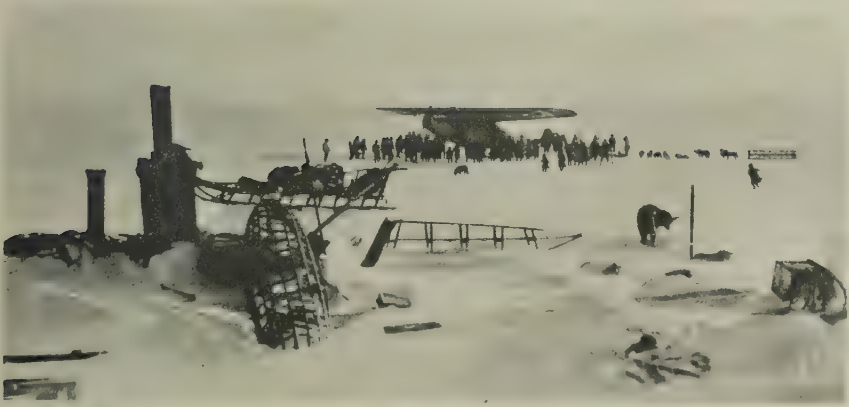

FIG. 7

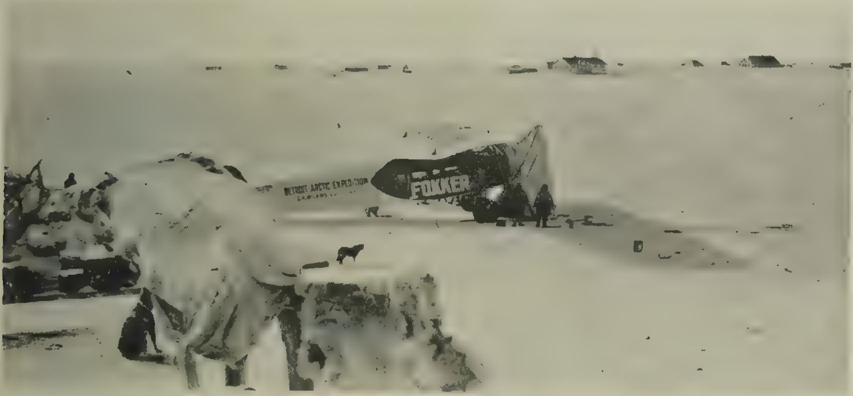

FIG. 8

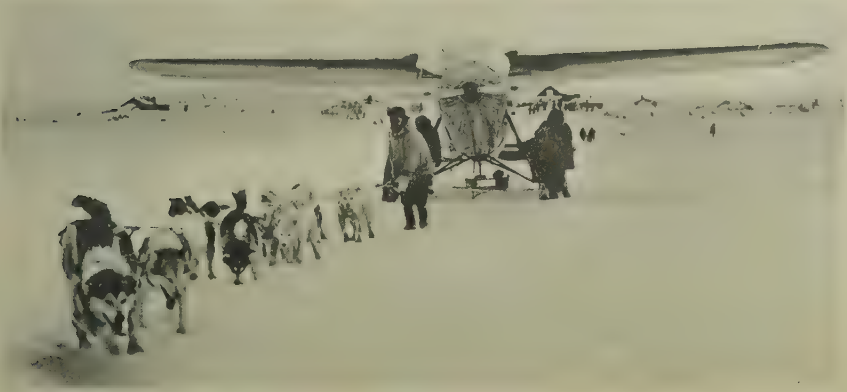

FIG. 9

FIG. 7—The *Alaskan* at Point Barrow, 1926.

FIG. 8—The machine was parked on the smooth lagoon ice, its engine housed in a windproof tent.

FIG. 9—The Lockheed Vega monoplane used on the flight from Barrow to Spitsbergen being hauled from the trading post at Barrow to the starting point.

myself as navigator, we set out on March 29 on a northwestward course, hoping to reach latitude 80°, longitude 180°. We planned to travel out six hours, land, take soundings, fly south for two or three hours, and then return to Barrow. We hoped to take advantage of meteorological conditions which would give us a favorable wind for the first four or five hours; calm conditions for the flight to the south; and, on the calculated movement of storm and wind, a following wind for the last four hours on our return.

The temperature was 42° below zero Fahrenheit at 6 a. m. when we started; a light wind blew from the east-southeast, which we expected would increase and swing to the southwest before we returned. As we proceeded on our course the temperature rose; the wind changed also, giving us additional speed, but did not change as rapidly as expected. Near Barrow there was much broken ice and many newly opened leads. This fact warned us that the storm was of greater proportions than I at first anticipated, but having started I was loath to turn back. We crossed ordinary pack ice most of the way. Four hundred miles out we came to old heavy pack, traveled over it for a hundred miles, and then came to ordinary pack again. Ahead we saw indications which led us to believe that we must be coming to shallow water: many open leads and pressure ridges could be seen in the distance. After five hours the engines started missing badly; ten minutes later we were forced to land. I immediately set about taking a sounding; Eielson looked for the engine trouble.

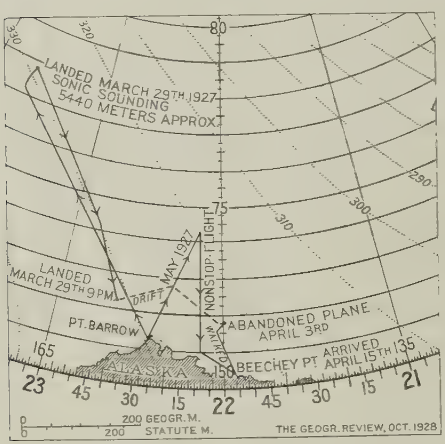

FIG. 10—The flights of 1927. On that of March 29, only two sets of astronomical observations were taken during the actual flight, the first three-quarters of an hour before the first landing and the second about an hour and a half after starting again. The actual position of the first landing given as 77° 45′ N., 175° W. is therefore principally dependent on the accuracy of the dead reckoning, though not entirely. After the second landing the drift of the ice was checked four times by double sets of observation on the sun.

We had landed on a section of comparatively young ice, about 700 yards long and 500 wide, between old floes. The ice beneath us was about three feet thick with very little snow on its surface. Two holes were punched through the ice, and echo soundings gave us a depth subsequently worked out as 5440 meters.[3] The estimate of our position was latitude 77° 45′ N., longitude 175° W. There seemed little possibility of finding land near by. It took half an hour to get the soundings and another half hour to get the engine going, and even then it worked only moderately well. After three attempts we managed to get into the air, but after a flight of ten minutes we were again forced to land. We then worked for two hours on the engine with fairly good results. It was by that time too late to attempt a flight to the southward; and, as we had expended a considerable amount of our gasoline, we decided to return direct to Barrow. While we were working on the engine the storm increased to alarming proportions: instead of being able to fly back with the wind we found that there would be a strong wind against us. We should undoubtedly drift to the west if we remained on the ice, and so I thought it advisable to attempt to return to Barrow at once.

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[3] *Geogr. Rev.*, Vol. 18, 1928, pp. 491–492.

For seven and a half hours we flew over a course which we had covered in less than five and a half hours on our outward journey and then, when our supply of gasoline gave out, descended through the hazy dusk to the ice. It was impossible for us to see beyond the windows of the machine, yet we came safely to rest on a smooth piece of ice with only slight damage to the skis on our machine. The bad weather prevented us from fixing our position until the next morning. Then we learned from two indifferent sun observations and an estimate of the drift of the ice that we had landed about seventy-five miles to the northwest of Barrow. The stormy weather was such that it was advisable for us to remain with the machine for five days, during which time we improvised sleds from the tail skid of the machine; and on the sixth day from a position some two hundred miles to the east of where we had landed we set out on foot headed for Beechey Point on the Alaskan shore, about eighty miles distant in a straight line.

We were equipped with spare clothing, sleeping bags, a Primus stove, and sufficient food to last us at least thirty days. The food consisted of a few ounces of pemmican but mostly of biscuits and sweet chocolate. We built for ourselves snow houses each night, and after two or three nights and in order to reduce weight we abandoned all but one half of a sleeping bag, in which we both put our feet at night. Our fuel when we left the machine was less than half a gallon; consequently we decided to eat our food cold and drink only cold water. We did not care to ration ourselves but found when we reached shore that we had consumed less than fifteen ounces of dry food each day. Even with this small amount we did not feel exhausted or hungry; and, although our packs, which we early substituted for the improvised sleds, weighed more than eighty pounds apiece we walked on an average more than ten hours a day and spent perhaps three or four hours more in preparation for camping and breaking camp. The reason why so much time was taken in making and breaking camp was because Eielson had so badly frozen his fingers that it was impossible for him to cut snow blocks for the house or to look after his own boots and clothing; hence this work fell to me and took up considerable time.

Much of the pack ice over which we crossed was so badly broken and so covered with soft snow that we found it impossible to walk, and the best means of progress was on hands and knees. It took us thirteen days of hard traveling. As we were nearing the coast we could see Beechey Point trading house a little to our left. Our navigation had been practically correct. We soon reached the trading station and in a week were again at Point Barrow.

Eielson had one finger so badly frozen that the two lower joints had to be amputated. This made it impossible for him to go out again on the ice that season; consequently with Alger Graham as pilot I set out with the second machine on a flight northeast toward Grant Land, expecting to reach Etah or the Royal North West Mounted Police Station on Bache Peninsula, opposite Etah. But the season was so far advanced that heavy fogs covered the Arctic Sea ice; and, although we flew for 250 miles out over the Arctic Sea, we never once, after the first 20 miles, saw any signs of the surface. To have continued would have served no useful purpose; and hence we returned to Barrow and, after waiting vainly for the weather to clear, went back on the fifth of June to Fairbanks, our efforts postponed until the season of 1928.

The Flights of 1928

As before, we left Seattle the second week in February. At Seward we experienced a delay of a week because of the unusual weather conditions. A thaw had set in, and the railway line to Fairbanks was blocked by heavy snow slides. We flew from Fairbanks to Barrow on March 19 and there set about the final preparations.

In 1927 I had planned to take advantage of the storm conditions that usually occur at Barrow some time between the last week in March and the first week in April; but in 1928 I decided to wait until after that storm period was over and take advantage of the fine weather which, judging from our own experience and the record kept at Barrow for the last twenty years, usually follows the storm. We expected to wait until a light northeasterly wind and other indications pointed to an anticyclone developing off Point Barrow, because I believed that the flying against this light wind for the first five hundred miles would be more than compensated for by the following wind which we should probably have at the end of our journey, providing of course that we did not find land. If we did find land, we proposed to come down and wait until we had the prospect of fine weather again at Barrow.

It was not until after three vain attempts that we were able to get in the air with the load we carried. We left the Elson lagoon just north of Barrow village at 10.15 a. m. on April 15. Once in the air we headed directly out over the ice on our course toward Spitsbergen (see Fig. 18).

Shore Conditions of Northwestern Alaska

The coast for many miles southwest of Point Barrow is bordered by tundra-covered banks ranging from five to thirty feet high. To the east of Point Barrow a long line of sand spits and islands shelter the mainland coast. Between the islands and the coast on the sea and lagoons during winter the ice surface is smooth and flat.

The ice near the coast at Point Barrow is generally broken and scattered between the first of July and the middle of August. A few miles offshore from Point Barrow the ice, even in winter time, is generally in motion: wide leads open and shut from time to time. Through the year there is generally to be found an open lead, boomerang-shaped, around Point Barrow and about three to ten miles out from shore.

At the shore-side edge of this lead there is usually a very large and wide pressure ridge. The greatest height measured at any one point on the ice ridge we saw was not more than forty feet, more usually the ridge was about six to eighteen feet high. The width varies but may average half a mile. While the same general conditions are found near the coast, they vary considerably; in no two years are they alike.

Fig. 11—Captain Wilkins about to start on the 1928 flight.

Details of Ice Crossed When Following Course

After crossing the smooth lagoon ice of our starting point we came to inshore pack ice fringed at the edge of the open water by a high pressure ridge. Beyond this to latitude 72°—a distance of about fifty miles—the ice was much scattered and broken, a great deal of clear water being exposed. This was due in my opinion to the fact that strong northeasterly winds experienced the few days before had broken up the ice which now was drifting with the ocean current.

The movement of the ice, I might mention here, is sometimes an indication of the direction of the wind to come. It seems that the influence of the wind on the ice travels through the ice much quicker than the disturbance travels in the air.

From latitude 72° to 73° we crossed high rough pack ice with a few narrow leads of open water running east and west on our course but turning to the north to our left. From latitude 73° to 75° there was old rough ice in which there were no open leads of water.

Newly frozen leads were observed, also other places showing where leads had been. It happened that on the day we passed they all were closed. Twenty-four hours later there might have been numerous leads. The snowdrifts on this ice were running east and west (all compass bearings quoted are true, not magnetic).

Between latitudes 75° and 77° we crossed much young ice lately frozen. This offered many perfect landing fields. Little snow had fallen since the leads had formed, and there were many square miles of flat ice without obstructions. Occasional good emergency landing fields had been observed throughout the journey, except in the much broken area near Point Barrow. Between latitudes 77° and 78° there was heavy old ice on what were high pressure ridges and high snowdrifts. At that point the direction of the snowdrifts changed suddenly from east and west to northwest and southeast.

From latitude 78° to 80° we were over a clouded area. For a hundred miles we flew over a flat-topped cloud that hid surface conditions. On the northern side of this area we saw some very old rounded ice. It was crystal clear on the surface and had probably not moved far from that spot. There were a few narrow fissures in this ice, but no wide leads or open water were seen. The snowdrifts ran east and west. In this area a meteorological station might be placed with safety on the Arctic ice.

From 82° to 83° we saw moderately rough ice with a few lanes of water at intervals. The snowdrifts in that region lay in a northeast-southwest direction. Then to latitude 84° there was light pack ice much broken and pressed, with considerable open water between. There were no great leads to be seen.

At this point we turned south and traveled over the clouds to Grant Land. From latitude 84° due east towards Greenland we followed wide leads running east and west; many pressure ridges were seen in this area, the pressure apparently coming from all sides.

Near Greenland the ice was very irregularly ridged with confused snowdrifts. Between longitudes 30° and 0° there were many narrow leads running east and west, young ice with low ridges, and snowdrifts running north and south. On the course between longitude 0° and Spitsbergen there were light billowy clouds, almost completely covering scattered ice and open water.

THE WINDS AND METEOROLOGICAL CONDITIONS

The average size of storm areas I had observed about Barrow was of a radius of 500 miles. My contention was that if we left Point Barrow at a time when a storm was about to develop, we could fly into a head wind which would gradually get lighter changing perhaps from northeast to perhaps southeast and south and that at a point about five hundred miles out on the ice we should meet a calm. In this case it was likely there would be, on the other side of the calm belt and in the neighborhood of Grant Land, a depression; by entering the edge of this depression we might have at first light, then stronger, winds to help us on the way to Grant Land and Greenland. At Point Barrow it was impossible to hazard a guess even as to the conditions we should meet at Spitsbergen. However, it was my opinion that, roughly speaking, the Arctic at that season of the year would be surrounded by a series of depressions of limited radius and that, if such should prove to be the case, we might expect after flying in a cross wind above Greenland and Grant Land to get into another disturbance as we approached Spitsbergen. If there was a disturbance in that neighborhood I believed it would center somewhere to the

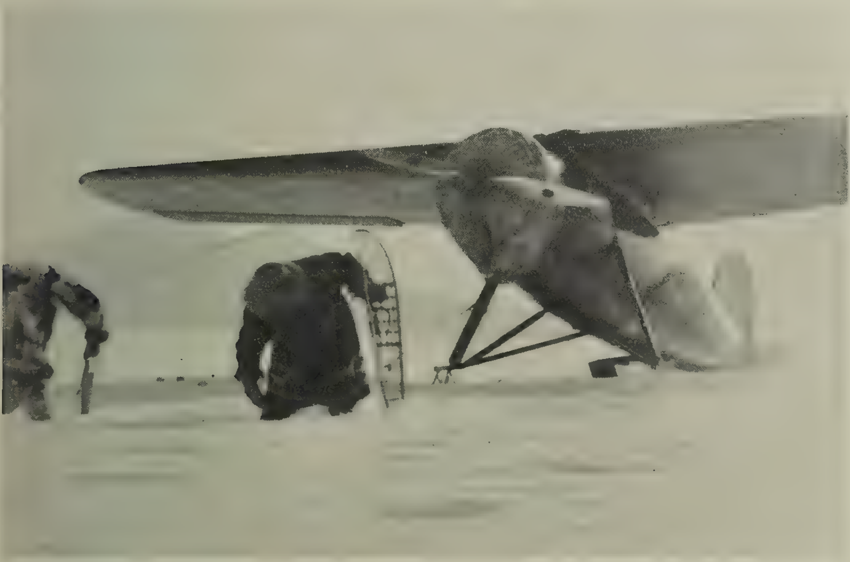

FIG. 12—Snowshoes for shovels. Digging out before the take-off for the flight from Green Harbor to the sealing ship which brought the machine to Norway.

south of Spitsbergen, about where the solid pack ice meets the warm drift from the Gulf Stream; its greatest influence would not be met north of the islands: therefore we should not experience head winds. I believed that the temperatures experienced north of Greenland would give me some idea of the intensity of the storm or depression.

These deductions were written down on April 22. On May 21, through the kindness of Mr. Otto Krogness, Director of the Geophysical Institute at Tromsö, I received copies of the meteorological charts covering the time of the flight. These charts are reproduced on pages 558 and 559. At the request of the American Geographical Society Sir Napier Shaw kindly undertook to prepare a brief discussion of the weather situation on the basis of the charts and the writer's observations.[4] This he has done in the succeeding article.

When we left Barrow the wind was from the east (all directions true, not magnetic) with a force of about ten miles an hour and was from the same direction when I took an observation some fifty miles from shore. Then for some time I was busy with other things, and when the next observation was taken the wind was from the north but very light, needing a correction for drift of only two degrees. We had risen from about five hundred feet altitude to three thousand feet. When we reduced altitude to about a thousand feet the wind was again from the east and gradually changed toward the south. When we were about four hundred miles out from Barrow I could see long stratus clouds forming behind us and a few dim cumulus clouds in the direction of Barrow where the sky had been clear when we left. Ahead we could see low clouds coming right down to the ice but not reaching a great altitude.

We climbed again to three thousand feet, climbing slowly and only reaching that altitude as the ragged edge of the clouds was met. For a few miles we could see through to the ice; then the cloud mass became more solid and flat-topped. The wind had been from the south when I took my last observation, but so far as I could ascertain as we flew over the clouds there was not any drift. It is impossible to say definitely whether this was so, because we were scarcely above the tops of the clouds and the only means I had of gauging our absolute direction was by taking a line on some slightly conspicuous cloud mass almost directly ahead while Eielson flew a straight compass course.

We passed over the thick cloud in about an hour, and my first observation when the ice was seen showed very little drift; but soon I noticed a slight wind from the northwest, which turned more westerly and increased in velocity as we approached Grant Land.

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[4] Since this article was set up the *Annalen der Hydrographie und Maritimen Meteorologie* for June, 1928, has been received containing a discussion by M. Rodenwald, "Die Wetterlage im nördlichen Polargebiet während des Polfluges von Hauptmann Wilkins am 16 April 1928," accompanied by a weather chart for the Arctic regions for 14 H. M. E. T. on April 16.

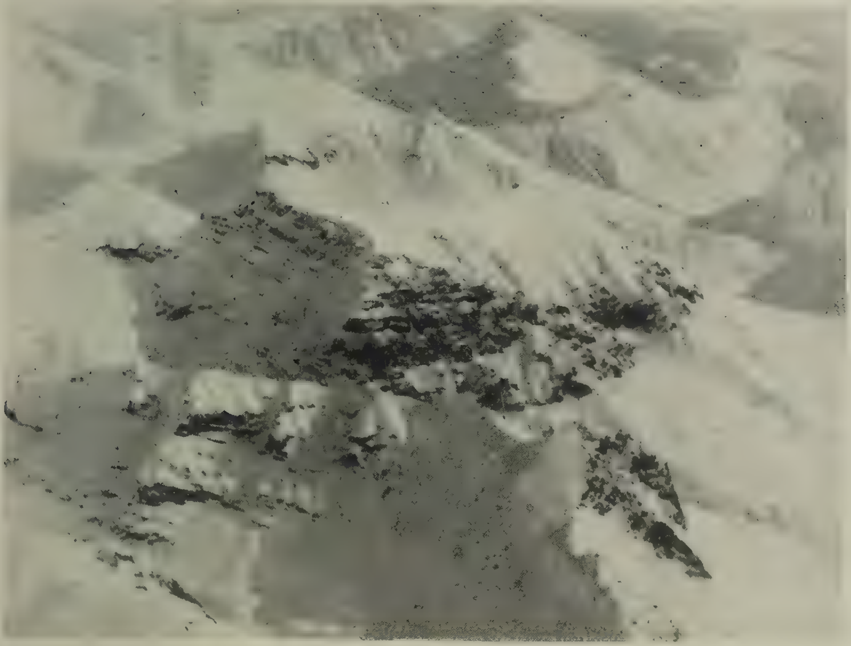


FIG. 13

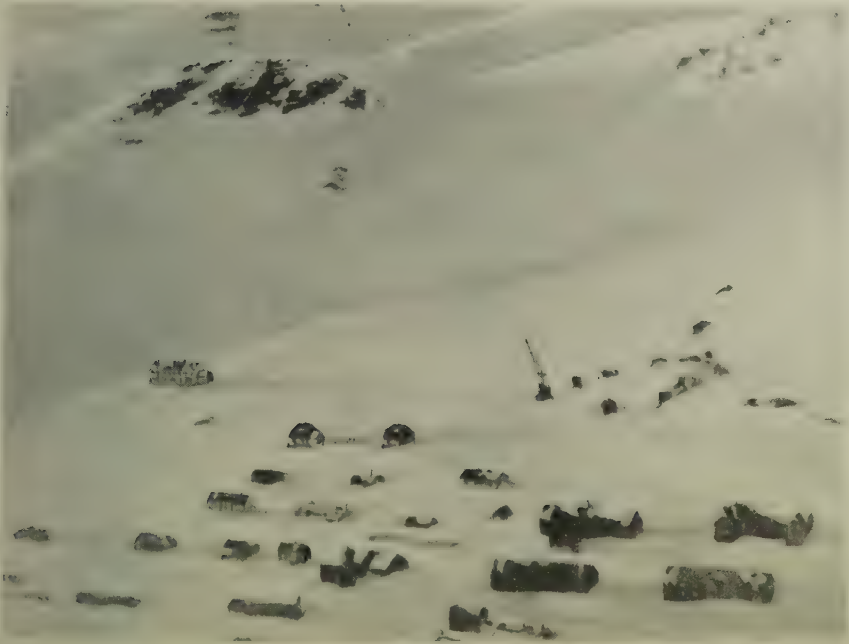


FIG. 14

FIG. 13—Mountains between Green Harbor and Advent Bay, western Spitsbergen seen from the air.
FIG. 14—Green Harbor. In addition to the government radio station Green Harbor is the site of a Dutch coal-mining concession.

In the neighborhood of Grant Land we could see to the right of our course high cumulus clouds in motion, very irregular, with the tops blown over by the wind. These were unmistakably clouds over land, and this assured me that we were not far from our plotted course. I could see a clear way round the clouds to the northward; but, in order to be absolutely sure by actually sighting land, I decided to keep on the course and turn south when we came near to Grant Land. After about twelve and a half hours out, just when we expected to be able to see the coast, it became necessary to turn from our course to the south to go round a high cloud mass. But the cloud continued too far in a southwesterly direction, and so we turned back to the east through the cloud for a few minutes. It was difficult flying, and I was just writing a note to say that we were near enough to Grant Land to be certain of it and to fly northward and go round the storm when Eielson shouted that he could actually see the land. We immediately swung north and for about thirty minutes saw intermittently a few patches of the Grant Land mountains.

As we swung clear of the cloud we encountered a wind from the north but soon passed through it into a calm area. The temperature in the cabin dropped noticeably to about zero. The thermometer outside read 48 below zero. The strait between Grant Land and Greenland was clear at its northern end, but over Greenland and beyond to the southeast we could see high towering cloud masses. Long stratus clouds streamed in the direction of the center of the disturbance, and low clouds hid the mountains of Greenland. I directed the course to the north of our track, telling Eielson to steer round the clouds. This he did. After two hours I could see one lone peak of Greenland showing up through the clouds, and for half an hour we kept this in sight. About the time we lost sight of it I could see ahead the cloud hanging over Spitsbergen. The compass or observation for drift was no longer necessary. We could steer our course by the shape of the clouds. We were in a wind from the northwest, and as we went toward Spitsbergen our ground speed increased.

About two hundred miles from Spitsbergen we encountered high cumulus clouds. We were not above them at 8000 feet but flew through cloud lanes and sometimes through the clouds themselves. Over the surface of the sea and sea ice the cloud tops were more or less level, but in the distance I could see much irregularity and believed that this condition was over Spitsbergen. It was then impossible to get the drift, but apparently we were in a high northwesterly wind. We headed toward the towering clouds, which appeared to be over the land; but on reaching these it was impossible to see through. To the east the clouds looked lower and flat; to the south they rose higher and promised to be more broken; and so we turned south, flying along what I believed to be the land cloud edge. In about fifty minutes and just 20 hours after we had left Point Barrow we saw two small mountain peaks penetrating the cloud tops. We took advantage of this opportunity to come down to within a few feet of the sea. The clouds were thick and extended practically down to the water. Beneath them the wind force was terrific. It was almost impossible to fly along the edge of the land and equally impossible to see the land when we kept out to sea. Fortunately, we had crossed a smooth patch of snow soon after coming down through the clouds; and I directed Eielsen back to it. Although it was difficult to find and difficult to land on, we came down safely. The wind on the ground was blowing from slightly west of north, with a velocity of forty or fifty miles an hour, and drifting the snow so much that we could see only a few yards.

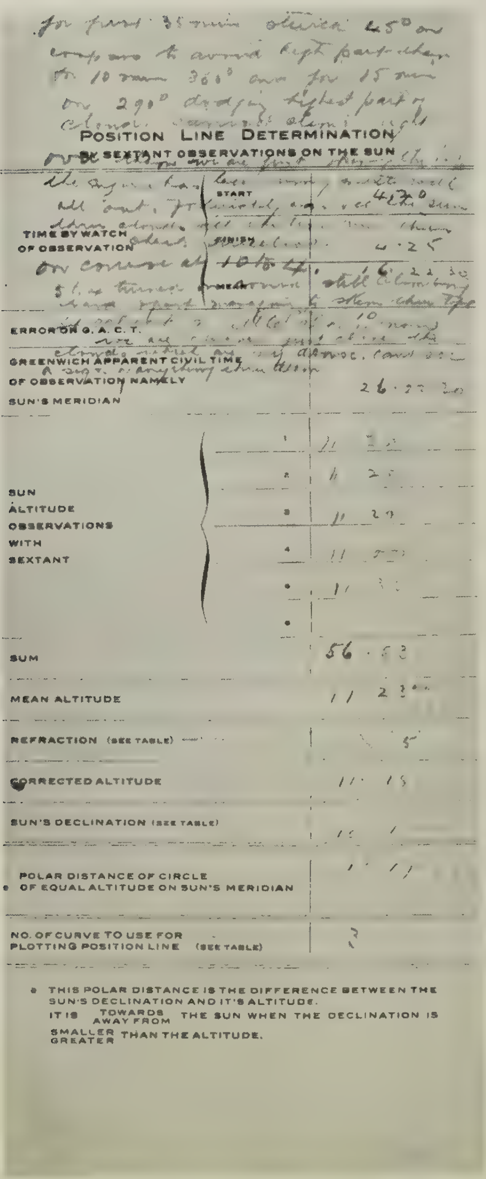
For five days the storm continued. The wind blew in general first from the north-northeast and then from the southeast, but no accurate observations were taken during that period. Our landing point we subsequently found to be Dödmandsören, so-called Dead Man's Island, the northwestern extremity of Ice Fiord.

A summary of the wind direction is as follows: for the first fifty miles on our course there was a light wind from the east; for the next two hundred and fifty miles, a very light wind from the northeast; for the next two hundred and fifty miles, the wind swung gradually through northeast to east and due south increasing in velocity. For the next two hundred miles we were either over a calm or over cloud where no observations could be taken. From the calm area we got into a light northwesterly wind, which swung more westerly and increased in strength until we came to Grant Land. From Grant Land we swung northward and out of the wind into a calm, clear, cold belt but entered a northwesterly wind again as we went beyond Greenland and approached Spitsbergen.

In general we could determine the weather ahead for at least two hundred miles. From Grant Land we could see the storm over Greenland some miles more distant. From north of Greenland we could see that a storm of great area and intensity would be met in the vicinity of Spitsbergen. The difference between cloud masses over the sea and the actual land was discernible.

NAVIGATION

Because of the difficulties expected with compass declination and dip it was thought that no type of compass would be of much use to the navigator; and, while we had proved that the English aperiodic compass was by far the most serviceable in Arctic conditions, I had found that an ordinary ship's lifeboat compass behaved very well in our plane during flights in 1927. However, the deciding factor was that we could not afford to buy anything that was not essential;



for first 35 min altered 45° on compass to avoid high part — then for 10 min 360° and for 15 min on 290° dodging highest part of clouds [illegible]

POSITION LINE DETERMINATION
BY SEXTANT OBSERVATIONS ON THE SUN

TIME BY WATCH OF OBSERVATION	START	
	FINISH	4·25
	MEAN	
ERROR ON G. A. C. T.		
GREENWICH APPARENT CIVIL TIME OF OBSERVATION NAMELY SUN'S MERIDIAN		26·22·30
SUN ALTITUDE OBSERVATIONS WITH SEXTANT	1	11 [illegible]
	2	11 25
	3	11 29
	4	11 [illegible]
	5	11 [illegible]
	6	
SUM		56 · [illegible]
MEAN ALTITUDE		11 23
REFRACTION (SEE TABLE)		5
CORRECTED ALTITUDE		11 [illegible]
SUN'S DECLINATION (SEE TABLE)		[illegible]
* POLAR DISTANCE OF CIRCLE OF EQUAL ALTITUDE ON SUN'S MERIDIAN		[illegible]
NO. OF CURVE TO USE FOR PLOTTING POSITION LINE (SEE TABLE)		3

* THIS POLAR DISTANCE IS THE DIFFERENCE BETWEEN THE SUN'S DECLINATION AND IT'S ALTITUDE.
IT IS TOWARDS / AWAY FROM THE SUN WHEN THE DECLINATION IS SMALLER / GREATER THAN THE ALTITUDE.

FIG. 15—Facsimile on half scale of a page from Captain Wilkins' notebook on the flight to Spitsbergen.

hence I decided to do without the aperiodic compass and make use of the eight-inch lifeboat compass already in my possession. The navigator's cockpit was also provided with a prismatic surveyor's compass, a British Royal Air Force bubble sextant, a pocket sextant, a Pioneer Instrument Company's drift indicator, a course-and-distance calculator, protractors—one arranged to serve as an azimuth circle—charts, log books, tables, design curves cut in celluloid, nautical almanacs, etc. (the charts, tables, and curves were those specially prepared by Mr. O. M. Miller, of the American Geographical Society's School of Surveying, for the use of the Detroit Arctic Expedition in 1926).

In theory the navigation of a course between Barrow and Spitsbergen was complicated, and its complications were magnified by the fact that we planned to swing to the east and not to follow a meridian of longitude north to the pole and south to Spitsbergen. On the course we planned to follow we should cross through 171 degrees of longitude and through a difference of 315 degrees of compass declination; and this in an area where the horizontal forces influencing the compass were small and perpendicular forces strong and unknown. The course plotted was a great circle course for the first 1300 miles, then it turned obliquely to the left on another great circle course for 900

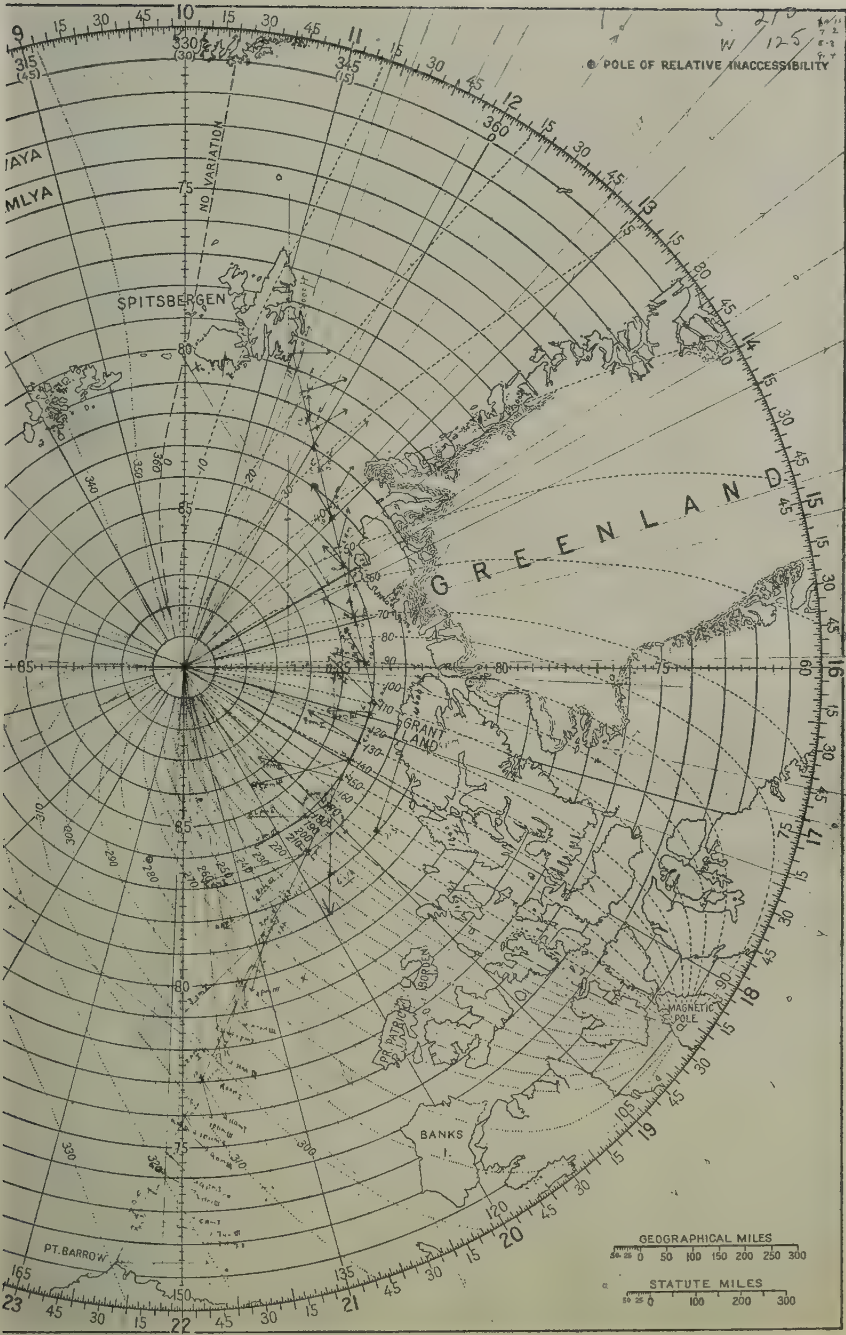


FIG. 16—Reduced facsimile of portion of arc of the actual charts used. A few of the position lines as plotted by Wilkins during the flight can be faintly discerned. The course shown with sun bearings along the route was plotted before starting and assured a particular time of starting and a constant rate of speed throughout the journey.

miles—2200 miles in all. I planned to make it in legs of one hundred miles, changing our course about every hour according to ground speed and meteorological conditions encountered. At first it appeared that the complications would make the steering of a compass course an impossibility, but I found on carefully working out the track, applying the corrections required for declination and the frequent change of longitude, that it would not be so difficult. The greatest change in our compass course would need to be during our ninth and twelfth hours of flight, but the greatest change in any one hour would not exceed twenty-five degrees. The actual change in direction of flight between the start and finish of our journey would be great. The first leg of our course would be in a direction only 18 degrees east of true north: on the last leg we should be flying only a few degrees east of south. It was a question as to whether our compasses would work at all in the air in some of the areas through which we should pass. But I hoped by means of keeping a careful check on drift and ground speed and by obtaining both altitudes and azimuths of the sun to be able to find the way.

Most of the actual notes of observations for drift and ground speed were lost on Dead Man's Island. The notes of changes of courses were passed to Eielson on the end of a long stick and were either thrown overboard by him at once or were later thrown out of the forward cockpit. These notes were generally a request to "steer five or ten or so many degrees to the right or left" as the situation demanded. Because Eielson's compasses were not always steady, I would hammer on the gas tank to let him know when he was on the right course. He would then, by "lining up" on some object in the sky or on the ice, keep the course until again asked to change direction.

The compass courses for each leg of the journey had been carefully worked out before leaving Point Barrow. At each observed position a new departure was taken and the course mentally calculated. After several observations had been taken it was seen that the compass was more or less correct and if necessary we could have steered a successful course by it alone. The checks, however, upon which I depended most for keeping in the right direction were the azimuth of the sun and the distant cloud conditions, which owing to the nature of the weather that day made the navigation of the flight comparatively easy.

During the flight, with the exception of the last two hours, it was always possible for me to see the sun and take observations for altitude (see Appendix A). The course as planned and the course followed as deduced from the astronomical observations are plotted together on Figure 18. I was not always guided by the observed position but sometimes compromised between the position obtained by the sun's altitude and the position estimated by dead reckoning.

No pilot will steer an absolutely accurate course. During odd moments the machine may swing off twenty to forty degrees and back again. Air speeds are a check; but often in our experience it was necessary to climb steeply to warm the engine, and at those times our air speed did not serve to give us an idea of speed over the ice. Again, it would be necessary to side-slip to lose altitude; and, although it was nearly always possible to take observations for ground speed and drift when the machine was level and in straight flight, the speed gained during the dives cannot be registered. I think it is hardly possible for any navigator to bring back an absolutely full and complete check on the direction and speed of a flight lasting for twenty hours and through a wide variety of conditions. It is my experience that a navigator gains through actual experience an ability to compensate for slight changes in direction, speed, and altitude in a manner that no amount of figuring could master.

During our stay on Dead Man's Island we were able to get several sights of the sun, and these placed us somewhere in the neighborhood in which we were. We knew that we were within a few miles of either Kings Bay or Green Harbor and felt sure that if we could get into the air on a clear day we could from an altitude recognize the country. When the weather cleared so that we could see something of the landscape, we were too busy clearing a runway to make observations; hence it was not until we were actually in the air and saw the radio masts at Green Harbor about twenty miles distant that we were certain that we were near Ice Fiord. It took but a few minutes for us to reach the radio station and to land and verify our position.

Summary

In summing up the conditions in the Arctic in relation to aircraft, my experience leads me to believe that both airplanes and airships may be used with safety at certain times of the year even without preliminary ground preparation. With adequate ground preparation aircraft may be used to traverse the Arctic at any season of the year. If the journey is to be one of exploration, then to reap the advantage of good visibility on the ground it is necessary to carry out the work, on the Alaskan side at least, during the months of March, April, and the first half of May. After that time the ground is likely to be obscured by low cloud and fog. I believe that airplanes with normal loads might find anywhere within a radius of 20 miles suitable ice conditions for landing on the Alaskan side of the pole. Conditions are not so favorable on the Spitsbergen side. I believe that men might be safely let down from an airship to the ice, either by taking advantage of a wind to counteract the steering way of the ship or by using a drag-rope anchor. I do not believe that any form of sea anchor would meet

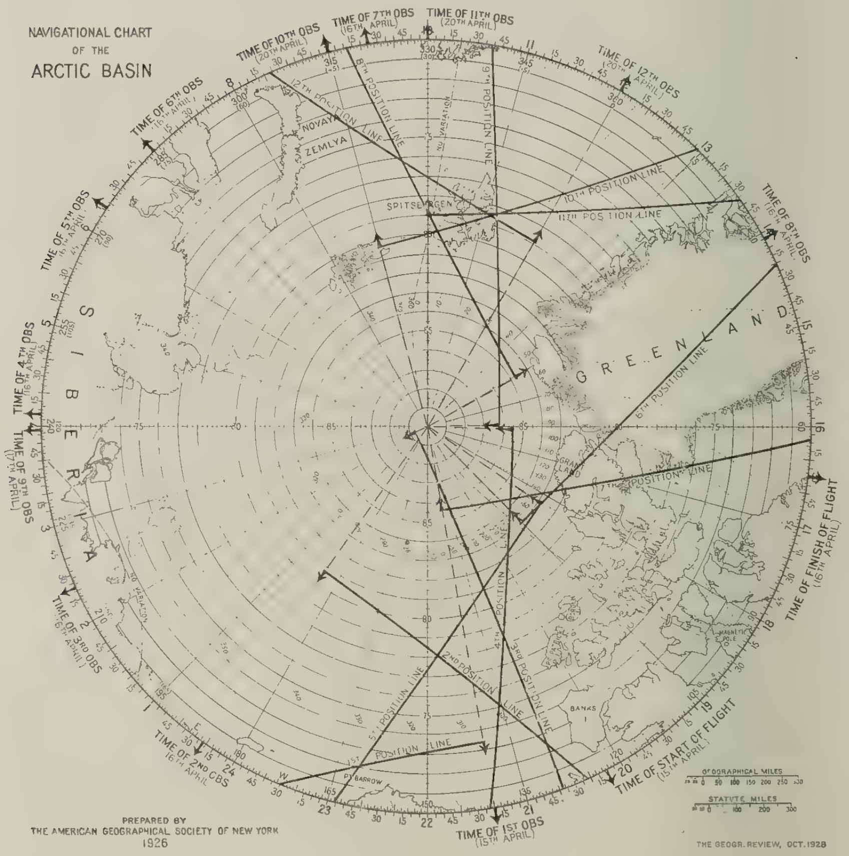
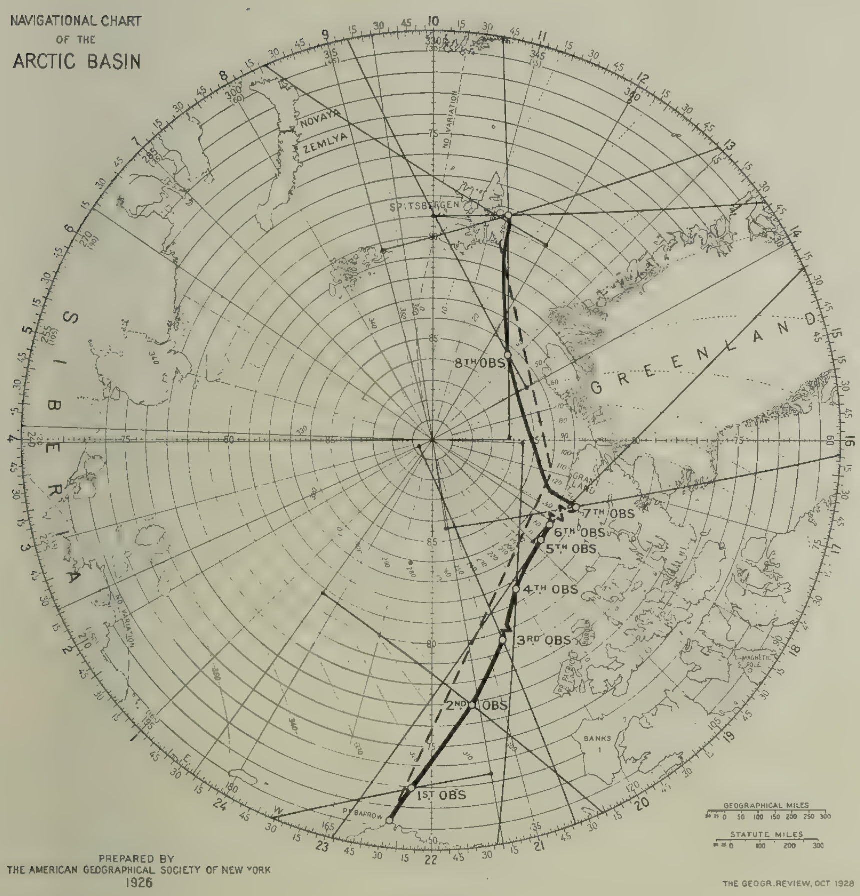

NAVIGATIONAL CHART
OF THE
ARCTIC BASIN
TIME OF 1ST OBS (15TH APRIL)
TIME OF 2ND OBS (16TH APRIL)
TIME OF 3RD OBS (16TH APRIL)
TIME OF 4TH OBS (16TH APRIL)
TIME OF 5TH OBS (16TH APRIL)
TIME OF 6TH OBS (16TH APRIL)
TIME OF 7TH OBS (16TH APRIL)
TIME OF 8TH OBS (16TH APRIL)
TIME OF 9TH OBS (17TH APRIL)
TIME OF 10TH OBS (20TH APRIL)
TIME OF 11TH OBS (20TH APRIL)
TIME OF 12TH OBS (20TH APRIL)
TIME OF START OF FLIGHT (15TH APRIL)
TIME OF FINISH OF FLIGHT (16TH APRIL)
1ST POSITION LINE
2ND POSITION LINE
3RD POSITION LINE
4TH POSITION LINE
5TH POSITION LINE
6TH POSITION LINE
7TH POSITION LINE
8TH POSITION LINE
9TH POSITION LINE
10TH POSITION LINE
11TH POSITION LINE
12TH POSITION LINE
NO VARIATION
SIBERIA
NOVAYA ZEMLYA
SPITSBERGEN
GREENLAND
GRANT LAND
BANKS
PT. BARROW
MAGNETIC POLE
GEOGRAPHICAL MILES
STATUTE MILES
PREPARED BY
THE AMERICAN GEOGRAPHICAL SOCIETY OF NEW YORK
1926
THE GEOGR. REVIEW, OCT. 1928

FIG. 17

OBSERVATION	DATE AND GREENWICH APPARENT CIVIL TIME	OBSERVED ALTITUDE	SUN'S DECLINATION	POLAR DISTANCE OF POSITION LINE ON SUN'S MERIDIAN	DEDUCED GROUND SPEED IN STATUTE MILES PER HOUR
Flight begun	15/4 $20^{H}\ 10^{M}$				
No. 1	15/4 $21^{H}\ 20^{M}$	26° 30′	9° 54′	+16° 36′	111
No. 2	16/4 $0^{H}\ 22^{M}$	19° 11′	9° 57′	+ 9° 14′	117
No. 3	16/4 $2^{H}\ 22\frac{1}{2}^{M}$	10° 48′	10° 00′	+ 0° 48′	122
No. 4	16/4 $4^{H}\ 07\frac{1}{2}^{M}$	5° 32′	10° 00′	− 4° 28′	106
No. 5	16/4 $6^{H}\ 16\frac{1}{2}^{M}$	2° 50′	10° 02′	− 7° 12′	88
No. 6	16/4 $7^{H}\ 0^{M}$	3° 00′	10° 03′	− 7° 03′	87
No. 7	16/4 $9^{H}\ 25^{M}$	5° 35′	10° 05′	− 4° 30′	
No. 8	16/4 $14^{H}\ 04^{M}$	15° 32′	10° 10′	+ 5° 22′	129
Flight ended	16/4 $16^{H}\ 30^{M}$				197
No. 9	17/4 $3^{H}\ 58^{M}$	6° 37′?	10° 21′	− 3′ −44′	
No. 10	20/4 $9^{H}\ 0^{M}$	21° 07′	11° 29′	+ 9° −38′	
No. 11	20/4 $10^{H}\ 0^{M}$	22° 30′	11° 30′	+11° −00′	
No. 12	20/4 $12^{H}\ 0^{M}$	22° 35′	11° 32′	+11° −03′	



NAVIGATIONAL CHART OF THE ARCTIC BASIN

PREPARED BY THE AMERICAN GEOGRAPHICAL SOCIETY OF NEW YORK 1926

THE GEOGR. REVIEW, OCT 1928

FIG. 18

FIGS. 17 and 18—Figure 17 shows the position lines plotted on the chart, which is a stereographic projection. It demonstrates the ease of the method employed. The time of observation having been marked on the perimeter of the chart, the latter acting as a 24-hour clock, the meridian over which the sun was crossing when observed is automatically determined. The distance from the pole where the position line, namely the equal altitude circle, cuts this meridian is shown in the adjoining table and is equal to the observed altitude minus the sun's declination. The position lines are actually drawn by means of suitable curves cut in celluloid, the most correct curve of a series of ten being chosen from a table with altitude and declination as arguments.

Figure 18 also shows the position lines but emphasizes the course actually flown (heavy solid line: the course laid out is dashed) as deduced from the astronomical observations and the dead reckoning. Where the course is shown as a zigzag (just after the 3rd observation and between the 6th and 7th observations) it is diagrammatic, as it is based on the narrative of the flight only.

all conditions. It would be useful on occasion; and both types of anchor should, if possible, be carried. It appears likely that ice sufficiently stable to accommodate a permanent party can be found in the Arctic, but the housings and equipment of that party should be as portable as possible.

APPENDIX A—REPORT ON THE ASTRONOMICAL OBSERVATIONS

O. M. Miller

The writer has studied Captain Sir Hubert Wilkins' actual record of astronomical observations taken on the Point Barrow to Spitsbergen flight and, after plotting the results freed from certain slight errors to be mentioned later, finds in them close corroboration of the statement that Wilkins flew within a few miles of the course laid out and that he thus accomplished a feat in navigation which can be confidently declared unparalleled in the history of flying.

The extreme difficulty of navigating in the polar regions across meridians instead of along them, especially when the magnetic declination is changing rapidly and the horizontal component of the earth's magnetism is weak, has already been explained.

It was owing to Wilkins' careful preparations and his skill and experience in navigating that he succeeded in keeping close to his intended course. It was not found necessary to place full reliance on the astronomical work during the flight and, because of an error of one hour in recording the time of one of the observations and owing to one or two slight mistakes in extracting the sun's declination, the excellence of the astronomical observations was not fully appreciated till later.

Wilkins made eight sets of altitude observations on the sun while he was in flight and four from the ground while at Dead Man's Island. These observations were recorded in a book specially prepared by the American Geographical Society for navigation in the polar regions (see Fig. 15 for specimen sheet). The position lines deduced were then plotted on the navigational chart immediately (see reduced facsimile, Fig. 16). The observations consist mostly of sets of five or six sun altitudes taken in rapid succession corrected for refraction to the nearest 5′ only. The probable errors of their means vary from ± 4′ to ± 14′.

Referring to Figure 17, it is of interest to note the effect of the position of the sun during the flight. Observations 1, 3, 4, and 8 give good checks on both distance flown and direction. The accuracy of observation 8 is corroborated by the statement in Wilkins' notes that at "3 a. m." (13^H G.A.C.T.) he was "abreast of end of Greenland." Observation 2 gives an excellent determination of distance flown, for when it was made the sun was dead behind the direction of flight. Observation 7 leaves little doubt as to the part of Grant Land flown over. Observations 5 and 6 are good checks on direction. The position lines deduced from observations 9, 10, and 11 all meet at a point on the southern edge of Dead Man's Island. The only observation obviously at fault is the last one.

APPENDIX B—FINANCES, EQUIPMENT, AND PERSONNEL

Expedition of 1926

The amount of my personal available funds, $15,000, was the nucleus of the 1926 Expedition. For exclusive right to have one of their staff accompany the expedition and record the daily happenings, the North American Newspaper Alliance agreed to pay $25,000. The *Detroit Times*, not a member of the Alliance, paid for the privilege of printing the news simultaneously with the members of the Alliance a sum of about $4000. The Richfield Oil Company of Los Angeles agreed not only to provide the gasoline required but to subscribe $5000 cash. The Pennzoil Company gave all the oil required and a sum of $1500. Pathé News agreed to pay $2500 cash and provide the staff, equipment, and traveling expenses in connection with the photographic record of the Expedition. The American Geographical Society, in addition to its scientific advice and support, subscribed $1000 in cash and the maps, special notebooks, tables, watches, etc. for the use of the navigator. In all $50,000 and much equipment became available.

The Detroit Aviation Society, anticipating aid from the citizens of Detroit, guaranteed all other necessary funds. The original estimate of funds required was about $95,000, but later the purchase of a second machine for $25,000 brought the figure to approximately $120,000. In order to pay cash for the equipment required, several members of the Detroit Aviation Society, some of whom were also members of the Expedition Board of Control and the Finance Committee, agreed to borrow from a bank at a nominal rate of interest the money required, hoping of course that the amount borrowed would be more than covered by popular subscription. In this they were disappointed.

The equipment selected for the 1926 expedition included one trimotored Fokker monoplane, powered with Wright Whirlwind engines, and one Liberty-engined Fokker monoplane. The Wright Aeronautical Corporation, of Paterson. N. J., provided three specially selected engines at a discount and made available, to be paid for only if used, a fourth engine. The three-engined monoplane, the first to be made of that size, 73 feet span, was manufactured in Holland and assembled at the Atlantic Aircraft Corporation factory at Hasbrouck Heights, N. J. The Liberty-engined machine had a 63 foot wing. A spare Liberty engine for this machine was the gift of Mr. Henry Ford. Adequate engine and airplane spares and complete tools for repairs and assembly were provided. Mr. Johnston, of Johnston Motors, Ltd., New York, presented a complete set of spare parts for the Liberty engines.

Each machine was fitted with wheels and carried a spare wheel, tires, and tubes. One spare landing gear was provided. Two sets of skis, to be attached to the axles beside the wheels, were provided. These detachable skis were expected to be used only on the trial flights and the flights from Fairbanks to Barrow.

The B. G. Corporation contributed all spark plugs and extras required. The Curtiss Reed Propeller Company provided a set of their propellers at minimum cost. Lieutenant Malcom Hansen, of Washington, D. C., built for the North American Newspaper Alliance a wireless airplane set which could be used either in the air or on the ground.

The personnel of the 1926 expedition included pilots Lieutenant Carl Ben Eielson, who had already flown in Alaska, and Sergeant Charles M. Wisely of Selfridge Field. The Wright Aeronautical Corporation loaned the services of A. Hufford, one of their staff, so that the expedition was relieved of the responsibility of finding a mechanic to service the Wright Whirlwind engines. The Atlantic Aircraft Corporation, in fulfillment of their contract, provided the services of a representative to supervise the assembly and trials of the Fokker planes. Major T. J. Lanphier, commanding officer of the first pursuit group, Selfridge Field, obtained leave to accompany the expedition. The North American Newspaper Alliance and Pathé News sent members of their own staffs to attend to the matter of collecting and forwarding news and pictures. The publicity section was quite separate and apart from the expedition, although naturally we welcomed the aid they gave.

Expedition of 1927

The bills of the 1926 expedition, including the expenses in connection with the snow-motor and dog-team party—not mentioned in the above account as it made no contribution to the effective work of the expedition—amounted to about $120,000. The estimated value of the equipment on hand at the end of 1926 was $30,000, in half of which property the Detroit Aviation Society rightfully owned an interest. At a meeting of the Detroit Aviation Society and the Expedition Finance Committee in November, 1926, it was resolved in effect that if I agreed to pay the Detroit Aviation Society 20 per cent of my earnings from future expeditions until $30,000 had been paid I might make use of the expedition's property and look elsewhere for further support. It should here be noted that at the termination of the 1928 efforts the

Detroit Aviation Society, with the understanding that all my earnings were to go toward financing an Antarctic expedition, very generously relieved me of all financial responsibility toward the Society.

Such was the financial position in November, 1926, when the Detroit News came forward and offered me $5000 for payment for the use of the expedition film and my services as a lecturer at 106 lecture engagements, which sum I agreed to pay into the funds for a new expedition. The Detroit News then most generously agreed, if I provided the equipment, to pay all the working expenses of the new expedition which was to be called "The Detroit News-Wilkins Expedition." The American Geographical Society provided at considerable expense a sonic depth-finding apparatus. The North American Newspaper Alliance was given the sole right of news, and while they gave no money to the expedition they agreed to send their representative at their own expense. The estimate of the costs for running expenses was $12,000.

After going carefully into performance figures it was decided to purchase for the 1927 expedition one Stinson Detroit biplane equipped with tank capacity of 225 gallons. The Stinson would serve for the short flights northeast and northwest of Point Barrow. For the flight to Spitsbergen it was intended to use the larger Fokker wing fitted to a Liberty engine and fuselage. There was sufficient condensed food and clothing left over from 1926, and as I had shipped 1500 gallons of gasoline and 150 gallons of oil to Point Barrow during the summer of 1926 there was no need to freight these supplies from Fairbanks.

The Detroit News generously loaned a second Stinson biplane. Thus we were provided with two Stinson machines supposed to be interchangeable in every part except the engine; the engines could be changed *en bloc*. We had skis and spares for the Fokker machine at Fairbanks and Point Barrow.

Carl Ben Eielson again accompanied the expedition as chief pilot. A second pilot was obtained in Alger Graham, late of the Stinson Aircraft Corporation, Detroit. The Detroit News sent their own representative in Mr. A. A. Smith, and the North American Newspaper Alliance provided two wireless operators.

Expedition of 1928

For the 1928 expedition I determined to carry out as far as personnel and equipment were concerned the ideas I had in 1926 before I was overpersuaded to take a big expedition with a number of men and duplicate airplanes. I would select the fastest plane capable of carrying the necessary polar sledging gear, sounding apparatus, and other scientific and navigational equipment, two months' food supply, a radio outfit, one pilot, and enough gasoline to cover a distance of 2700 miles. In previous years the services of mechanics had been engaged; but this time I decided to be my own mechanic and besides attending to the business details, the navigation and preparation, to look after the engine myself.

The return from the sale of the Fokker machine brought in less than $10,000 clear. I received a little less than $10,000 for the Stinson biplane. The cost of the Lockheed Vega standard machine that I selected as the plane for my purposes was $12,500; but, what with the extra instruments, spares, transportation, etc., the actual expenses in connection with the machine were much more. A short-wave radio set was provided at an expense of over $1000, and incidental expenses brought the total amount to more than $20,000. For the privilege of having the trade signs painted on the machine the Richfield Oil Company paid $1000, and the Pennzoil Company $750. A kind friend in Los Angeles, who wishes to remain anonymous, subscribed $500, and the late James B. Ford, through Dr. Isaiah Bowman of the American Geographical Society, made available $600. I provided a further $3000 of my own money and so by doing without financial backing from any newspaper syndicate I was able to avoid the necessity of preliminary publicity.

The Lockheed Vega plane was of standard cabin design with just a few alterations for the convenience of Arctic navigation and for the accommodation of sufficient gasoline and supplies. In detail they amounted to a different distribution of windows, an arrangement to give maximum light in the navigator's cabin and to facilitate his ability to take observations of the sun and for drift and ground speed. This necessitated two windows in the floor and so allowed constant observation. An addition was made to the instrument board in front of the pilot. It held—besides the ordinary tachometer, thermometer pressure gauge, altimeter, air-speed indicator, and watch—an additional altimeter registering accurately to two feet, a turn-and-bank indicator, a fore-and-aft inclinometer, a lateral inclinometer, one fast-moving compass, and one slow-moving compass.

Our equipment included—besides the two sets of sounding gear, water-sample bottles, deep-sea thermometers, and snappers for obtaining bottom samples—combined seal spear and ice chisel, an axe, a small alpine axe, an apparatus for securing seals from the water, two rifles, 350 cartridges, 3 snow knives, a saw, two pairs of snowshoes, two half sleeping bags with waterproof covers, strips of deerskin to place beneath our bags, a wind-proof and waterproof tent with a waterproof flooring, straps for making packs of our sleeping bags, a duraluminum-shod runner which we could fix to the upper part of the fuselage and so construct a sled canoe in case of an accident to our machine, a Primus stove, two cooking pots, cups, plates, and spoons, four half-gallon containers for fuel, one of them filled with alcohol, another filled with ether to be used either for starting the engine in cold weather or in case surgical operations following an accident were necessary, bandages, medicines, a complete field surgical outfit, a small quantity of tobacco and some coca leaves to be used for alleviating hunger, two canvas covers for the engine and special stoves for heating them, fishhooks, fish nets, and sinkers. The fish net could also be used on the end of the seal spear for netting small auks and other birds should we find ourselves marooned on one of the Arctic islands. Our spare clothing with what we wore provided for each man two fur shirts, two pairs of fur socks, fur breeches, sealskin breeches, one pair of cloth breeches, four pairs of Angora woolen socks, two pairs of sealskin winter boots, two pairs of sealskin summer waterproof boots, two pairs of fur mittens, one pair of waterproof mittens, silk snow shirts and silk snow trousers, tooth brushes, tooth paste, hair clippers, safety razors and shaving cream, soap and a towel, a small mirror, a small pocket compass, sheath knives and small files for sharpening them, a magnifying glass, a waterproof box for matches, handkerchiefs, a sewing kit, silk and sinew for repairing boots and skin clothing, two pairs of snow glasses, and a Primus bottle.

For food we carried five pounds of sweet chocolate, twenty pounds of biscuits, twenty pounds of pemmican, twenty-four pounds of malted milk in tablet form, and five pounds of raisins.

ARCTIC WEATHER OF APRIL 15–16, 1928

WITH SOME OBSERVATIONS ON POLAR WEATHER IN RELATION TO THE GENERAL CIRCULATION

Sir Napier Shaw

THE reports of Sir Hubert Wilkins' flight across the polar region from Point Barrow to Spitsbergen and the additional information obtained from the Geophysical Institute of Tromsö give a flash-light picture of polar weather in April. Keeping the geographical pole on the left and the magnetic pole on the right, the course passed within 350 sea miles of the chief center of geographical attraction. It is an interesting region for a geographer to traverse; the deviation of the north point of the compass from the geographic north, what sea folk call the "variation," changed through 313°, from 330° "west of north" at the start (compass pointing 30° E. of N.) at Point Barrow to 17° west at Spitsbergen. The flight from Point Barrow to the first landing at Spitsbergen took 20¼ hours of impartial civil time, but it would count as a day and a quarter, 30¾ hours, according to true solar time as kept by sailors at sea.

POLARITY OF WEATHER

The region has also a special interest from the meteorological point of view. All the well-known theories of the general circulation of the atmosphere—Maury's or James Thomson's or Ferrel's and even V. Bjerknes' and, with a dislocation of the northern pole from 90° to somewhere in Greenland, W. H. Hobbs's also—are zonal and have a certain symmetry about the pole. The question naturally arises, "Is there really a meteorological pole about which weather is symmetrical?" And if so, "Is it really centered by the rotation of the earth at the geographic pole or is it somewhere like the magnetic pole not actually coincident but still near enough to be regarded as paying at least a proper respect to the earth's rotation?"

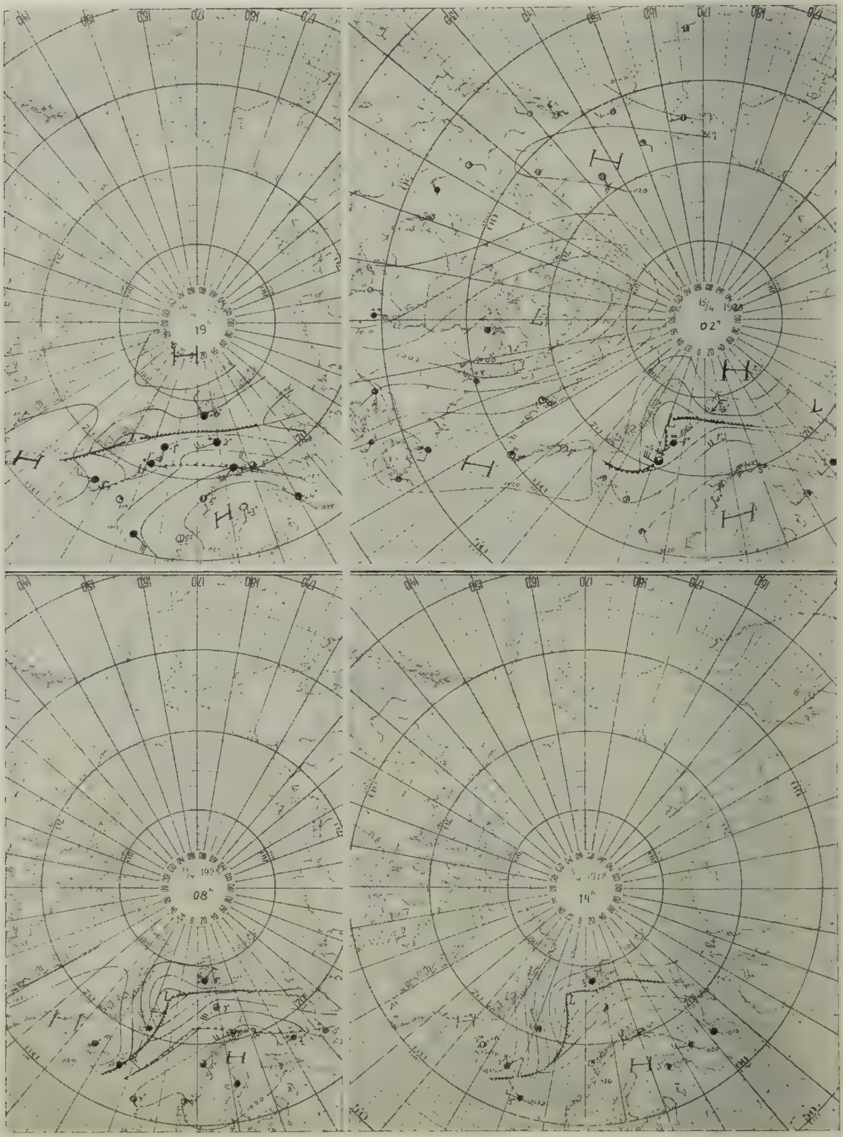
Meteorologists are not quite agreed about the polarity of weather. If I have rightly understood what I have read, there is a view that, in so far as the earth's atmosphere is left in peace and quietness, it would settle down with cold air over the polar regions and warm air over the rest of the world, with a well-defined surface of separation between the two which marks a discontinuity of temperature and wind and which arranges itself as a conical or [cylindrical] surface with its axis coincident with the earth's true axis. Its boundary meets the earth's surface at a small inclination somewhere about latitude 60°. The sweet simplicity of the ideal arrangement is sadly impaired by "the slings and arrows" of the weather; still the discontinuity between equatorial and polar air, to which nature is forever addicted and is always trying to set up, can be recognized wherever it can be found on a map. We see it in the separation of warm and cold air in a cyclonic depression; indeed, according to this view, a cyclonic depression in its inception is nature's own reaction against the existence of the discontinuity—her own creation. In actual practice the discontinuity demonstrates itself in the form of bursts of cold polar air bulging and spreading southward between successive cylconic depressions.

Summing up briefly, the polar-equatorial discontinuity is an inherent characteristic of the earth's atmosphere and its rotation; it is disturbed but not destroyed by atmospheric convolutions; it is at once the condition precedent of the formation of a centralized depression and the condition to which the atmosphere will return when the depression has worn itself out.

There is another view, namely that the bulges or surges of cold air and such lines of discontinuity as are found on maps, between them and the warm air which they invade, are the ultimate consequence of the chilling effect of "slope" in the polar regions—chilling in the polar winter on account of the radiation to the sky in the polar night and chilling also in the summer, in spite of the long hours of gentle sunshine, on account of the accumulation of snow and ice on the polar slopes.

By an inexorable law of convection cold air will go down chilled slopes, and the "slope effect" (which is in itself the real part of land and sea breezes) will provide an inexhaustible supply of cold air to the surface of the Arctic region in winter and summer but especially in winter and early spring. What extent or steepness of slope is necessary to keep up a measured supply is still undetermined; and how many of the land areas of the polar regions are efficient purveyors of cold air is also a matter for consideration. The tundras of the Asiatic coast line and of the Barren Grounds of northern Canada count for little. Alaska counts for a good deal, and Greenland for so much that it may perhaps be considered as Nature's effort to provide a weather pole in the north, as Hobbs pictures it, that, like the magnetic pole, shall not be simply subservient to the universal general.

Emphatically we may assert that the air of the north polar regions is not independent of the general circulation; it is certainly not exempt from the tyranny of pressure; the equator is the better place for that kind of freedom. We can hardly conceive of increase of pressure except as convergence of upper air, using its velocity to provide the necessary compensation for the destruction of pressure difference which is the inevitable consequence of the drift of air from high pres-



sure to low at the surface. From that point of view the Arctic basin is rather a good theater for the staging of a high-pressure drama by the general circulation; the local influences we can only regard as humble but very amusing players, like Nick Bottom and his friends in "A Midsummer Night's Dream."

In the *Monthly Weather Review*[1] A. J. Henry has been asking where

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[1] A. J. Henry: Whence Come Cold Waves?, *Monthly Weather Rev.*, April, 1928, pp. 142–144: reference on p. 144.

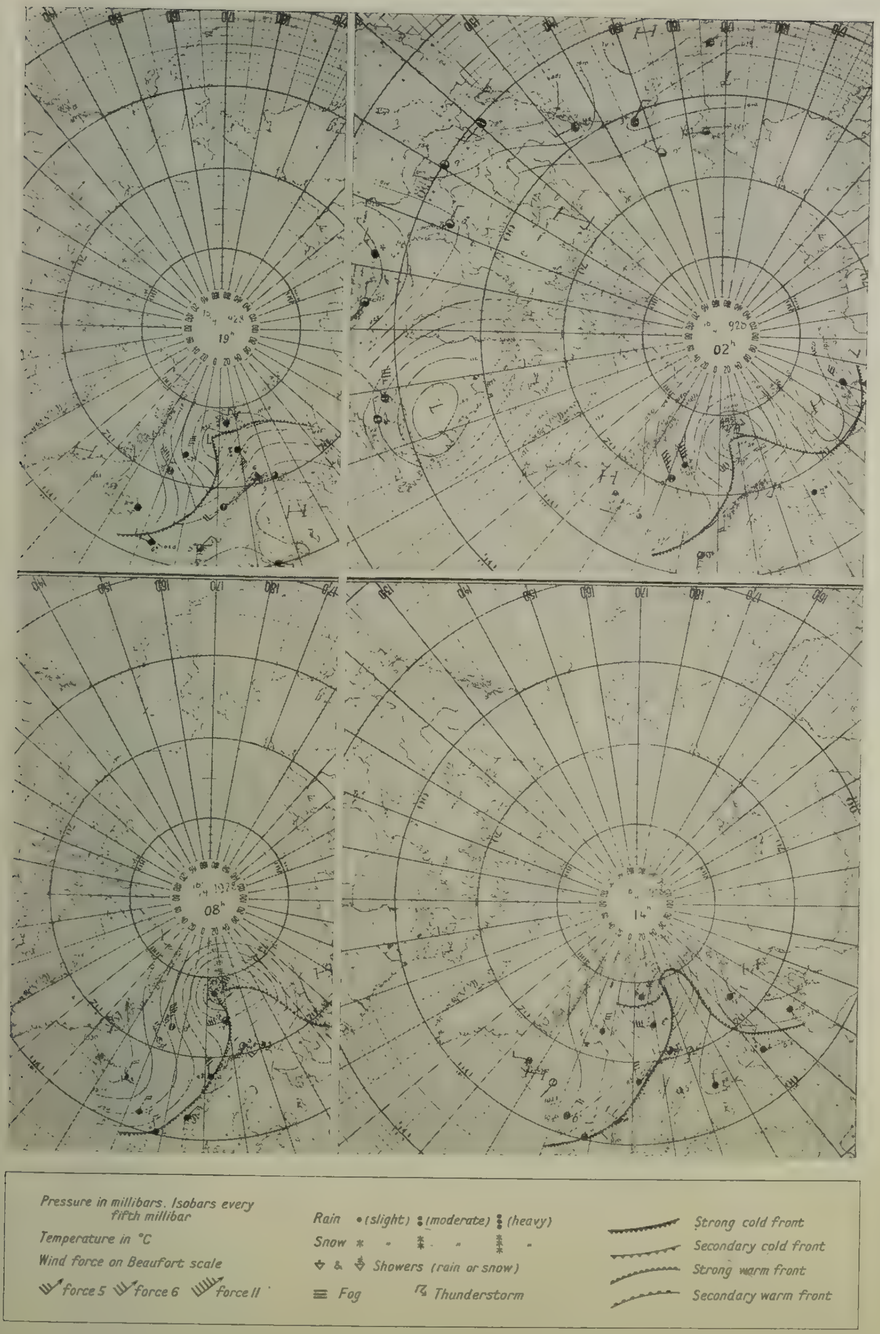


FIG. 1—Reproduction on a reduced scale of weather charts furnished by the Director of the Geophysical Institute at Tromsö for 19 h. April 14 (Central European time) to 14 h. April 16, 1928, showing the development of the storm over Spitsbergen in which Captain Wilkins landed. For a diagrammatic representation of the advance of the cold front see Figure 2.

the cold waves come from and uses the international data for 1882–1883 for the Arctic for his information. He says:

> In conclusion it may be said, for North America at least, the evidence of the three international Polar stations is against the idea that aperiodic thrusts of cold air Equatorward take place, and that even under a more favorable distribution of reporting stations than now exists it would be difficult to identify any particular thrust with a subsequent cold wave in temperate latitudes. The cold waves of the latter region, if we may express a belief based on many years experience with the daily weather charts, are doubtless due to an initial southward movement of air which takes place in accordance with the pressure distribution of the moment, most probably about north latitude, say, 60° to 70°, but not necessarily within the polar basin, plus the effect of intense radiation from the snow and ice-covered surface of the continental interior.
>
> The evidence of the Fort Rae station—a station situated, if not within the place of origin of cold waves, yet very close thereto—is adverse to the concept of an outbreak or thrust of cold polar air Equatorward. The speed of the wind at that station on the average of the three winter months is but 1.8 meters per second (4 miles per hour), and high winds are conspicuous by their absence. During the coldest days of the months, November to March, the prevailing wind direction was NNW., although it was calm an equal number of hours. The next most frequent wind direction was SSE., or in the exact opposite direction. The winds from the last named were equally cold with those from a northerly quarter, thus indicating a thorough mixing of the lower layers and a sort of equilibrium temperature after a day or so of northerly winds. Although the Point Barrow station is 18° farther north, the temperatures registered thereat are somewhat higher than at Fort Rae in the cold season.
>
> It is quite probable that cold waves entering the North American Continent by way of the Mackenzie River Valley may have had their place of origin in extreme northeastern Siberia, in the valley of the Anadyr River. A movement thence to western Alaska is but a short journey and almost wholly over a land surface.

Bearing these things in mind let us look at Sir Hubert Wilkins' records. He sailed (in the air) with light or very light head wind or no wind at all for 1000 miles. Off Grant Land at 08 G. C. T. of the 16th at 3000 feet he got into a light northwest wind, which represented a general flow from the polar region round a cyclonic center over Spitsbergen that had set itself up in the interval from 18h. of April 14.

Six hours later he was within 200 miles of Spitsbergen and on the way to the center of a storm which had been visible in the distance for four hours and had developed a very unwelcome intensity.

THE TROMSÖ CHARTS

The Geophysical Institute at Tromsö has supplied charts for April 14, 18h; 15, 1h, 7h, 13h, 18h; 16, 1h, 7h, 13h, G. C. T., in which the separation of polar air from equatorial air is marked. The progress of the cold and warm fronts is indicated by the charts. The story begins with a line of discontinuity running along the shore of the Denmark Strait to the center of a "low" at the eastward extension of Greenland and from there onward passing just south of Spitsbergen to Novaya Zemlya. The part along the Greenland coast is a "cold front" facing east-southeast, the continuation of the same line to Novaya Zemlya is the boundary of equatorial air forming a warm front facing northwest. The winds of the equatorial air represent in effect a flow of air supplied from the southwest, covering the whole of the Greenland Sea and with a light air running slowly eastward on one side of the discontinuity while on the other side polar air coming from Novaya Zemlya moves past Spitsbergen towards Greenland. Just off the Greenland coast, with a northerly wind on its left and a northeaster on its right, is the beginning of a "low" which separates the polar air that is flowing off Greenland from the equatorial air that is moving over the sea.

Successive maps show the cold front as the bulging eastward of the air from Greenland, which gets stronger as the cyclone develops and is reinforced by air coming from above latitude 80° and curling into the very strongly developed depression. In the meantime there is rain or heavy snow within the area of the low, especially in Spitsbergen. In the course of the advance of the cold front from the Greenland coast the whole of the Greenland Sea south of Spitsbergen up to the Norwegian coast is swept clear of equatorial air; but there is hardly any advance of equatorial air northward. The cyclone, which was so violent that a wireless operator at Kings Bay lost his life in an attempt to make a short distance out of doors, moved its center only slowly.

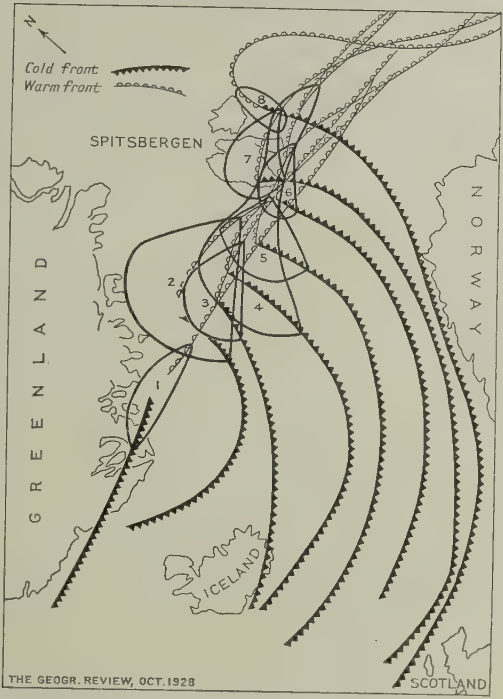
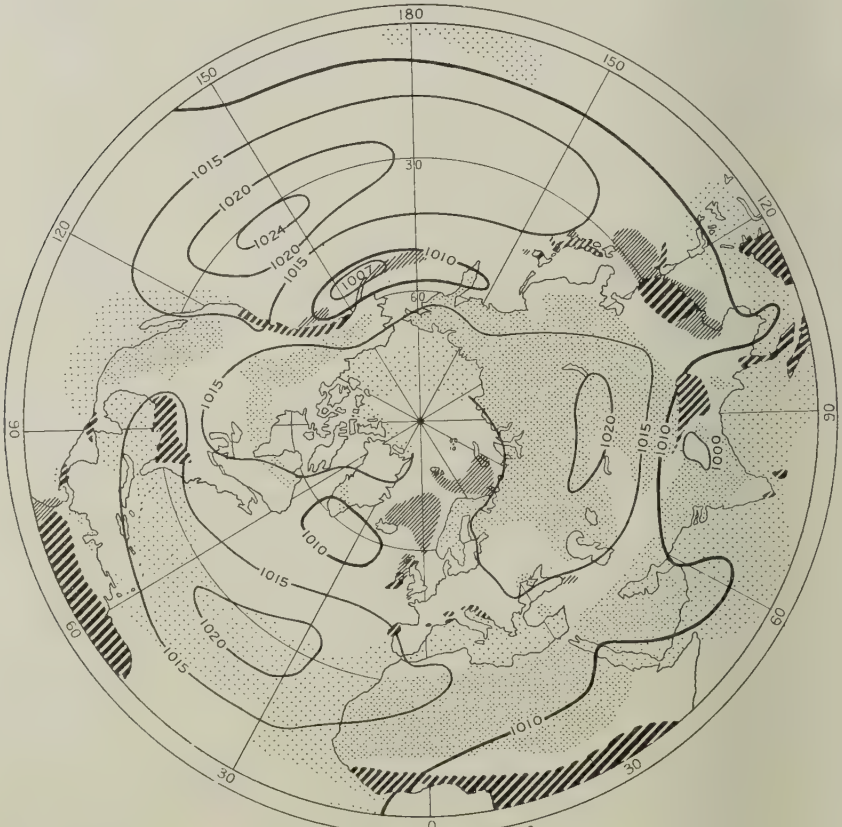


FIG. 2—Chart of the march of the cold front from Greenland to the Norwegian coast from April 14, 18 h. (G. C. T.) to April 16, 13 h. (G. C. T.), based on the charts of Fig. 1. The storm center for the successive 6-hour intervals is shown by numbers 1 to 8. The pressure falls from 1005 millibars at 18 h. April 14 to 985 millibars at 14 h. April 16.

Altogether the flash-light picture shows that on this particular occasion the idea of Greenland as a weather pole for supplying cold air scores. The storm took two days to develop. In the course of a year there is time for nearly two hundred of such flash-light photographs. In this particular one, slope effect and rain or snowfall are prominent. Slope effect is one aspect of convection, and rainfall or snowfall is another. Let me here remark that we are thus entitled to regard convection as an important meteorological factor.

I have lately been disposed to study the general circulation of the atmosphere from the point of view of our knowledge of convection; and the events of April 14 to 16 would suggest that Greenland, on account of its slope, is a sort of pole of downward convection and Spitsbergen a center of upward convection. Whether the slopes of Spitsbergen are sufficient to give it on other occasions a local polarity is a question more easily asked than answered; but this occasion invites us to pursue somewhat further the relation of convection to the general circulation.



THE GEOGR. REVIEW, OCT. 1928

Fig. 3—Map of the normal distribution of rainfall and cloud over the northern hemisphere in the month of April, with lines showing the normal distribution of pressure in millibars. The heavy ruling represents rainfall greater than 100 millimeters (4 inches); the lighter ruling, cloudiness greater than 7 over land or sea; the close stipple, rainfall less than 25 millimeters (1 inch); open stipple, cloudiness less than 2 over land and less than 5 over sea.

THE DISTRIBUTION OF RAINFALL AS A GUIDE TO THE GENERAL CIRCULATION OF THE ATMOSPHERE

Convection as a meteorological agent has not yet been studied to the extent which it deserves. It has been thrown into the theories of the general circulation and assumed to belong to the hypothetical zonal distribution without any adequate examination of its capacity or its limitations.

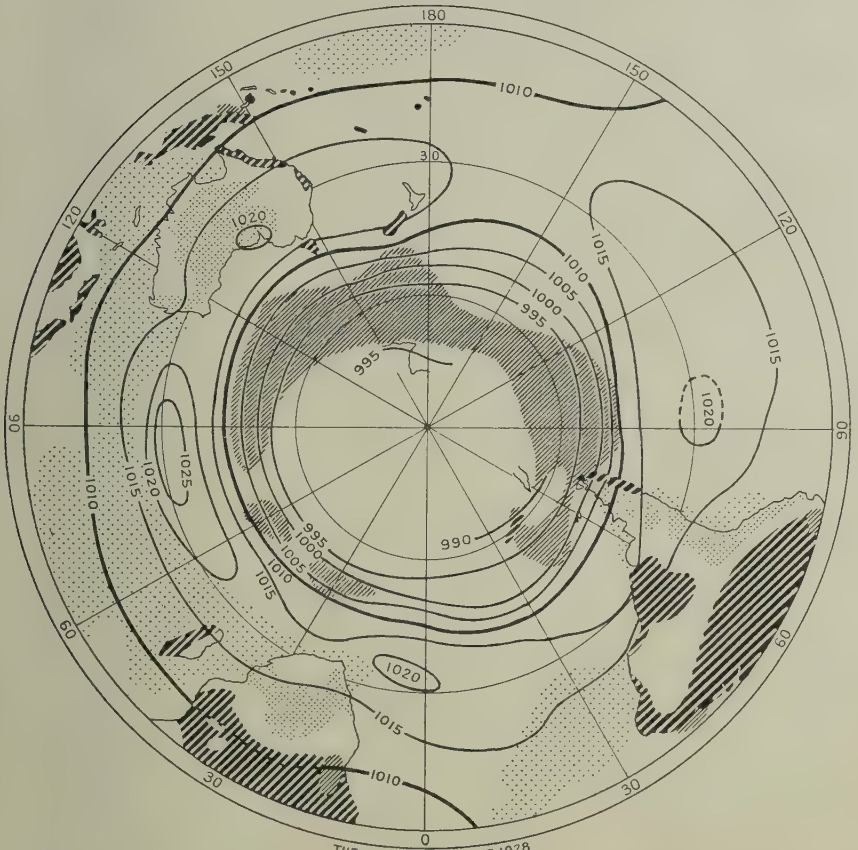


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FIG. 4—Map of the normal distribution of rainfall and cloud and pressure over the southern hemisphere in the month of April. See Figure 3 for explanation of symbols.

If we allow that convection is the controlling principle of the general circulation the subject may be approached in a reasonable way by examining such data as there are for evidence of convection and its distribution over the globe and fitting in the general circulation to the facts as thus elicited instead of assuming a general circulation on a zonal plan and tossing in the convection as a life buoy to keep the theory afloat.

Copious rainfall may be accepted as substantial evidence of upward convection of saturated air in the atmosphere not far from the locality where the rain is registered. So a map of the distribution of rainfall over the globe is at the same time a map of the distribution of convection. The upward convection may indeed be regarded as proportional to the rainfall. Where there is no rainfall there is no upward convection in the sense in which we use the word with reference to the general circulation, and where there is much rainfall there must have been much convection in the same sense. Upward convection implies convergence or advection to supply the place of the air which has gone upward, and advection in one locality implies downward convection and "divection" in another with horizontal movement between the two to complete the circulation. Orbis terrarum in tres partes divisus est: regiones advectivas sive convectivas, regiones divectivas, et regiones intervenientes sive medias.

Using rainfall as an index of upward convection and the absence of rainfall as an index of the possibility of downward convection, we can divide the surface of the earth into advective regions where there is relatively heavy rainfall, divective regions within which the air comes down and from which it is distributed over the surface, and the intervening regions over which the air passes from the divective regions to the advective regions.

On a synchronous chart of the distributions of pressure and wind, anticyclones, where there is little or no rain, appear as divective regions, and cyclones which are generally rainy as advective regions. So it may be on maps of the normal distribution of pressure; areas of high pressure may be associated as divective regions with areas of low pressure as advective regions with intervening regions of straight isobars marking localities of variable winds with resultant flow from a divective center towards an advective center.

To test this suggestion I have tried to use maps of the distribution of rainfall as a guide to the advective and divective regions.

Provisionally I have taken a monthly fall of more than 100 mm., 4 inches, as a mark of identification of an advective region where air ascends and similarly a fall of less than 25 mm., 1 inch, as the mark of a divective region where air descends. Superposing them on a map of the distribution of pressure the suggestion will be confirmed if in the normal there is high pressure in the divective region and low pressure in the advective areas. The isobars of the intervening areas will show the direction of flow.

We have monthly maps of rainfall over the land but most unfortunately none over the sea; and the world with the sea left out is not good enough. However, we have figures for cloudiness over the sea as well as the land, and there should be some connection between normal cloudiness and normal rainfall. So I have made an attempt at guessing a relation that would enable me to identify advective and divective regions.

On the coasts, cloudiness 7 works in pretty well with a rainfall on the land of 100 mm. So over the sea we may try cloudiness greater than 7, as a provisional index of an advective region. For the divective regions things are not so simply arranged. Over land rainfall less than 25 mm. seems to go with cloudiness 2; but over the sea there is no region with so low a figure. Cloudiness less than 5 is more rare than rainfall over land less than 25 mm. So as a first experiment I have tried cloudiness less than 5 as the index of a divective region over the sea.

It is not only the sea for which suitable data are lacking; there are the polar regions for which we have no adequate information about rainfall or cloud, and for these localities we meet with a special difficulty about the equivalence of the two on account of fog. A fog at sea that prevents an observer from seeing anything else is logged as cloudiness 10, the same as overcast sky, even if the fog does not reach beyond the masthead. Now fog may be associated with slope effect, or downward convection; but cloudiness 10 would put it in the opposite category. Consequently the small number of data which exist for the Arctic basin afford little or no help in classifying the locality or a part of it as advective or divective. That is a great misfortune.

With all these failings I present a map of the northern and southern hemispheres showing the normal positions of the advective regions, the divective regions, and the intermediate regions for the month of April derived from the maps of normal distribution of rainfall, cloud, and pressure for that month in my "Manual of Meteorology," Vol. 2, Figs. 111–112, 81–82, 138–139. It is suggestive but not exactly conclusive.

GREENLAND AS A DIVECTIVE REGION

From the fact that on April 15–16 air flowed off Greenland to take part in the formation of snow and rain about Spitsbergen we are on safe ground in regarding Greenland as a divective region. Parenthetically, that is, I believe, the real meaning of Professor Hobbs's glacial anticyclone. Spitsbergen may have been an advective one during Wilkins' flight, and the suggestion may quite well rank as a normal experience.

Wilkins saw a storm behind him when he was leaving Point Barrow, another storm over Greenland was visible from Grant Land, and Spitsbergen was enveloped for two days in a storm which he saw from north of Greenland.

There is an interesting passage about cyclonic depressions in these regions in the paper by A. J. Henry to which reference has already been made.

> The pressure records at the Point Barrow show that the station is more frequently visited by intense cyclones than might be supposed. The fact that deep cyclonic systems approach the Alaskan coast of the Bering Sea area from the winter pressure minimum of the Aleutians makes it not only probable but certain that at times an intense cyclone passes eastward along the coast of northern Alaska. One such passed close to or over the station on January 12, 1882, having a central minimum pressure of 28.266 inches and winds of hurricane velocity.
>
> Four days later the most severe wind storm in the life of the Fort Conger Station was experienced. The two stations are 1200 miles apart and a travel on the part of the cyclone of but 400 miles a day would accomplish the journey.

Rasmussen in the account of his Arctic travels among the Eskimos has many references to blizzards in winter in the Barren Grounds west of Hudson Bay. Lockyer's maps of isanakatabars (equal ups and downs of pressure on the barogram) in "Manual of Meteorology," Vol. 2, Figs. 204–206, show a zone of maximum range of 19 mm. about 60° in the southern hemisphere and in the northern hemisphere two separate regions of maximum with about the same range, one covering the North Atlantic and its coastal areas from Hudson Bay to Novaya Zemlya, the other smaller area covering the Aleutian Islands, Alaska, and the Bearing Strait.

It is at least curious that the north polar basin and the central north shores of America and Asia are outside the maximum area so that southern Greenland and the Aleutian Isles appear as special centers of conflict between "polar" and equatorial air and probably, therefore, advective regions in comparison with divective regions covering the interior of Greenland and the polar sea.

We must wait for further investigation of the polar basin before we can complete our setting of the general circulation as the expression of convection and its consequences.

MONTE VISTA: SIXTY YEARS OF A COLORADO COMMUNITY

Ralph H. Brown

University of Colorado

MONTE Vista, situated in the western part of the San Luis Valley of Colorado, is a small town of distinctly American stamp bearing but few marks of the long Spanish stewardship of which its name is suggestive.

The rapid recent spread of Middle Western culture in this region anciently identified with kingly land grants and extensive cattle ranches is, indeed, its most striking characteristic. Names of features and places and here and there groups of adobe dwellings occupied by Mexican families are all that remain of Spanish culture in the Monte Vista region. On the other hand, but fifty miles away beneath the towering sierra of the Sangre de Cristo which forms a definite eastern margin to the great San Luis Valley the life of vast Spanish land grants, now managed by Americans, continues in nearly complete isolation. Thus in a half-day's journey by automobile across the nearly featureless plain of an intermontane lowland, whose altitude is over seven thousand feet, one may view a manner of living but little altered by the advance of the American frontier with the plowed fields and settled permanency of the Middle West which in the vicinity of Monte Vista has transformed the landscape.

THE REGION BEFORE MODERN SETTLEMENT[1]

From 1819, under undisputed Mexican control of the southern part of the state, settlement extended but slowly northward into the Colorado section of the San Luis Valley, partly, no doubt, because of the forbidding aspect of the San Luis Hills which divide the valley into two unequal parts.

Land grants were awarded to notable men who had rendered services in the establishment of the republic. "There was an abundance of land, and so the grants were large; the land had little value, and so frequently no attempt was made to determine accurately the limits of a grant. This loose system of disposing of the public domain was of interest to the United States because by the Treaty of Guadalupe Hidalgo (1848) which ended the Mexican War, our government pledged itself to respect valid titles to land in the ceded territory."[2] After the award of the land grants a number of small villages or "plazas" were founded. Thus there appeared in the Sangre de Cristo Grant of 1843, involving a large portion of Costilla County, the settlements of San Luis (1851), San Pablo (1852), and San Acacio (1853). The Luis Maria Baca Grant, confirmed by Congress in 1860, in the northeastern part of the valley, was an outpost of civilization of the Mexican type. The Conejos Grant, in Conejos County, also placed land titles on a more secure foundation, thus removing one cause for retarded settlement. Others such as the Medano and Trinchera brought similar results.

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[1] See C. B. Goodykoontz: The Exploration and Settlement of Colorado, in "Colorado: Short Studies of Its Past and Present", (Univ. of Colorado Semicentennial Ser. IV), Boulder, 1927, pp. 42–90.

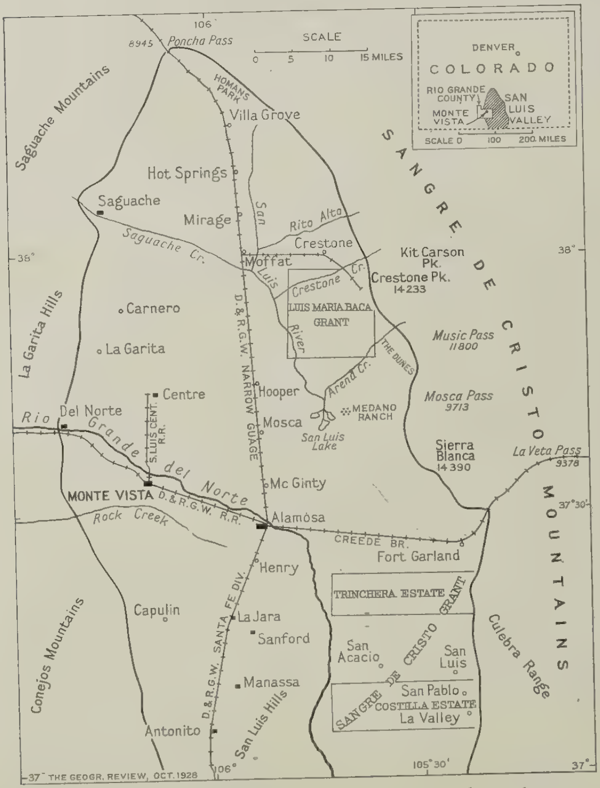

Fig. 1—Location map of Monte Vista, Colorado. Scale 1 : 1,600,000.

Fur trading added little to the settlement of the region although traders appeared in the valley at least by 1822. Passes across the eastern mountains became known partly through them and by the explorations of Frémont and Pike. The latter in his search for the source of the Red River, crossed the Sangre de Cristo in winter and finally found a large river which he thought to be the Red but was later chagrined to learn that it was the Rio Grande del Norte. He built a substantial fort on the Conejos River; but with the decline of fur trading about 1840 this and other forts lost significance and were replaced by government posts to protect settlers from the Ute Indians. The first fort, called Fort Massachusetts (1852), was soon replaced by Fort Garland (1858), whose ruined adobe walls are in plain view to the present-day tourists who cross the mountains over La Veta Pass.

The surrounding mountains, especially the San Juans to the west, attracted gold seekers after the Colorado Gold Rush of 1858. Until that time the San Luis Valley was a nearly unknown region despite its several hundred inhabitants and despite also the published reports of explorers and the writings of travelers. As a transit region to mining camps beyond, the valley became increasingly familiar, but the stage of permanent settlement was slow to follow.

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[2] *Ibid.*, p. 53.

A Desert Reclaimed by Middle Westerners

Only sixty years ago the first settlers from the Middle West arrived in the vicinity of Monte Vista which, with its annual rainfall of a little over seven inches, is quite the driest part of Colorado. For the most part the country was barren, quite unlike the landscape of the prairie states. In place of deep black loam, nearly everywhere the soil was sandy, liberally sprinkled with rounded stones. To be sure there were low bushes, but these by their gnarled and stunted growth seemed to bespeak a harsh struggle for existence and thus added to, rather than detracted from, the general desolateness. It was a desert (Fig. 2).

On the other hand, there were facilities for irrigation: a light fertile soil and the slight but uniform slope of the large alluvial fan constructed by the Rio Grande, which carried ample supplies for watering. On these are based the present community with its population of three thousand and a valuation of two million dollars. Its development has not been altogether easy: for the injection of a Middle Western culture here meant temporary sacrifices on the part of people many of whom are now living; it meant the development of new institutions; and it meant many mistakes, the effects of the most glaring of which are still plainly to be seen.

To the casual eye the site of Monte Vista is chiefly notable for its physical uniformity. However, the nearness of the alluvial fan to the mountains on the western edge of the valley, together with varying combinations of slope, drainage, soil types, depth of ground water, alkali and natural vegetation, largely altered by man, have modified the cultural landscape by differentiating four geographic types. These are the Rio Grande Bottoms, the Vegas, the Seep Lands, and the High Lands.

The Rio Grande Bottoms

The Rio Grande Bottoms (Fig. 3) suffer by comparison with other reclaimed portions of the Monte Vista region. The grass-large-tree vegetation scantily clothes the sandy-loam-to-gravelly soils. The surface is broken into isolated flats by the braided channels of the river, rendering the land incapable of close utilization and adding so much to the cost of bridge building that few north-south roads cross the river.

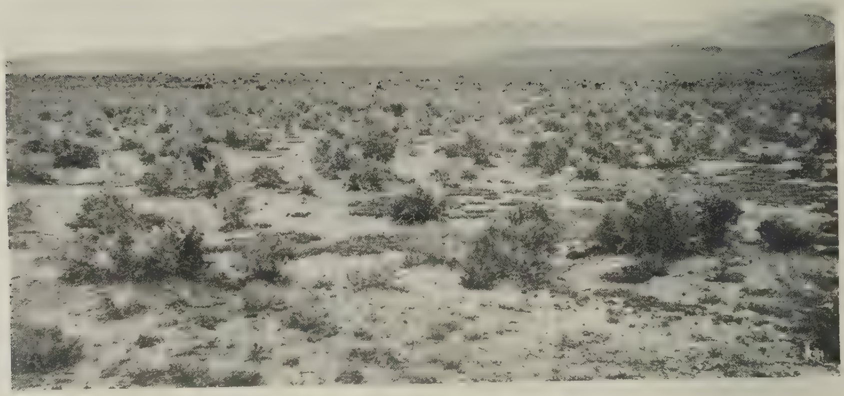

FIG. 2

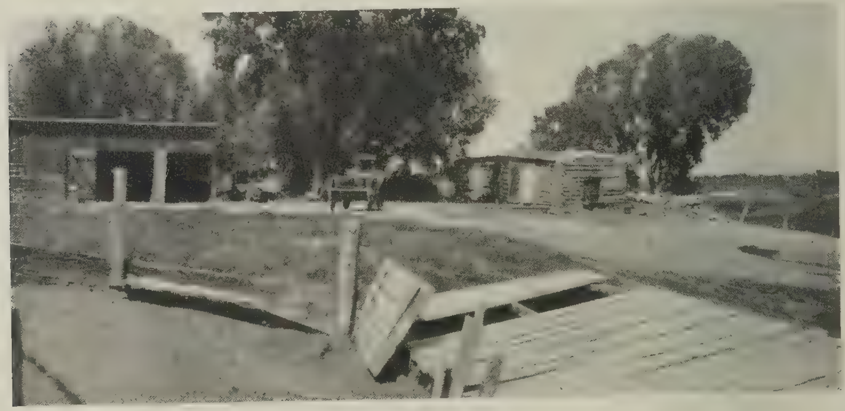

FIG. 3

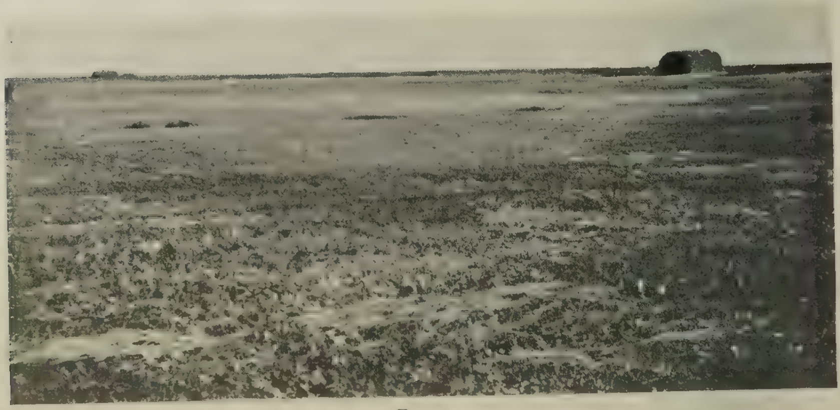

FIG. 4

FIG. 2—The untouched landscape of the western San Luis Valley. In the distance are the Conejos Mountains.

FIG. 3—A log house in the Rio Grande Bottoms, which still retains some features of pioneer life.

FIG. 4—The Vegas, natural grasslands of the Monte Vista region.

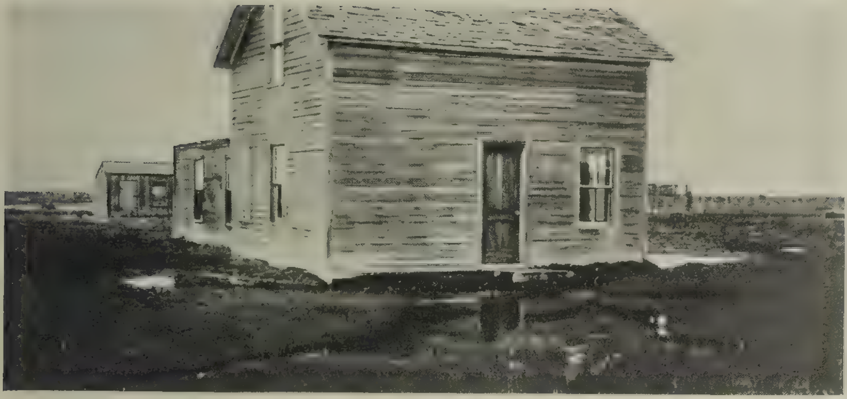

FIG. 5

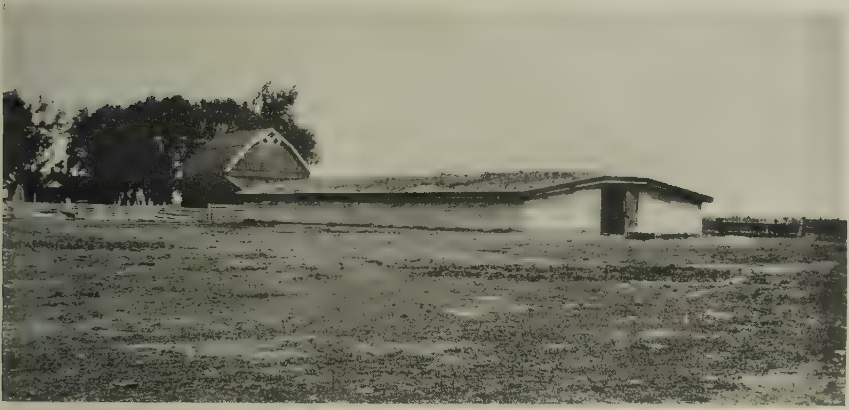

FIG. 6

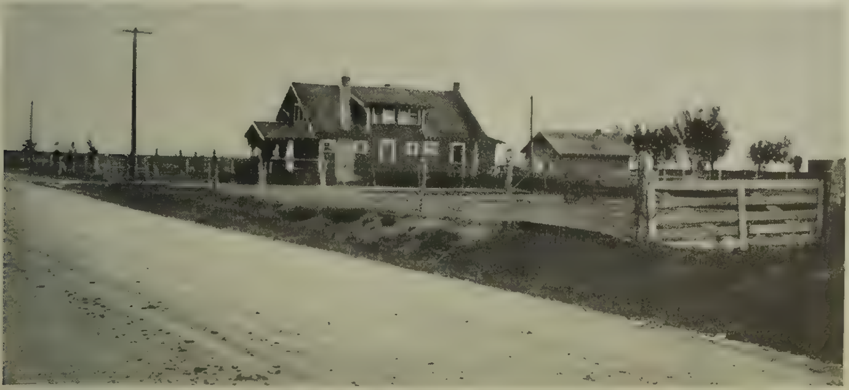

FIG. 7

FIG. 5—House on the Seep Lands abandoned because of inundation.
FIG. 6—A potato "cellar," built aboveground for dryness.
FIG. 7—A typical farmhouse in the High Lands, north of Monte Vista.

The bottom lands, largely nonirrigated though closest to the main source of water, retain not a few features of pioneer life. Many families live in log houses (Fig. 3), and farm equipment and buildings generally show evidences of disrepair. Many attractions to early settlement later impeded continued progress. In the bottom lands, for instance, short ditches of small volume sufficed for irrigation. Seepage rendered the surface soil moister than that of the higher lands, an aid to irrigation and also the fundamental reason for the grove-like vegetation which was the more attractive because of the barrenness of the surroundings. There was less surface accumulation of alkali here than elsewhere; and the sandy soil, which was well worked over through its close association with the graded Rio Grande, could be tilled with relative ease.

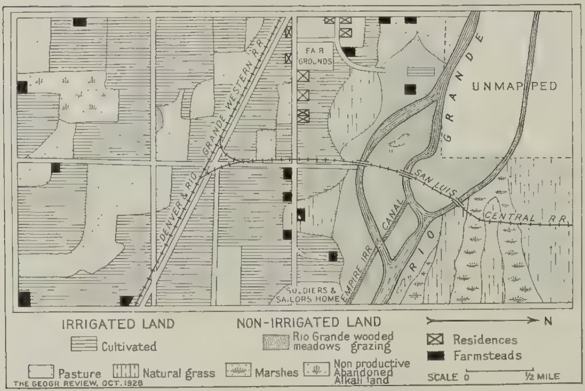

FIG. 8—Land utilization one mile east of Monte Vista in the Rio Grande Bottoms.

The present use of the lands near the river (Fig. 8) is typical of the Monte Vista region as a whole in which seventy-five per cent of the land is used in some connection with animal industries. That this stage of culture still persists is due to the close relation of dry plain to humid mountains and to the limited number of crops adjusted to the growing season of one hundred and ten days. Fruits are excluded by the brief spread between killing frosts and by low nocturnal temperatures induced by air drainage.

Thus in the Bottoms cattle range over the scant nonirrigated grasses or feed upon irrigated native pastures. Elsewhere irrigated native grasses and alfalfa are cut for hay, while patches of barley and oats provide additional winter food in this cornless region. Farther from the river potatoes and wheat are raised. Floods, which occur about once in six years, are a hazard; and the consequent destruction to live stock, crops, soils, and buildings is a still further present-day handicap of the Bottoms. The control of the flood waters of the Rio Grande is a step that should be taken immediately, since it will not only put economic activities on a still more permanent basis but will allow further land reclamation and will protect drinking water from contamination farther down the fan slope where the ground water movement is slow.

The Vegas

The Vegas (Figs. 4 and 9) are characterized by broad sweeps of open grasslands along Rock Creek, one of the few tributaries of the Rio Grande to resist absorption by the thirsty sands and gravels of the upper fan. These lands were settled at an early date because, again, irrigation was here a relatively simple matter.

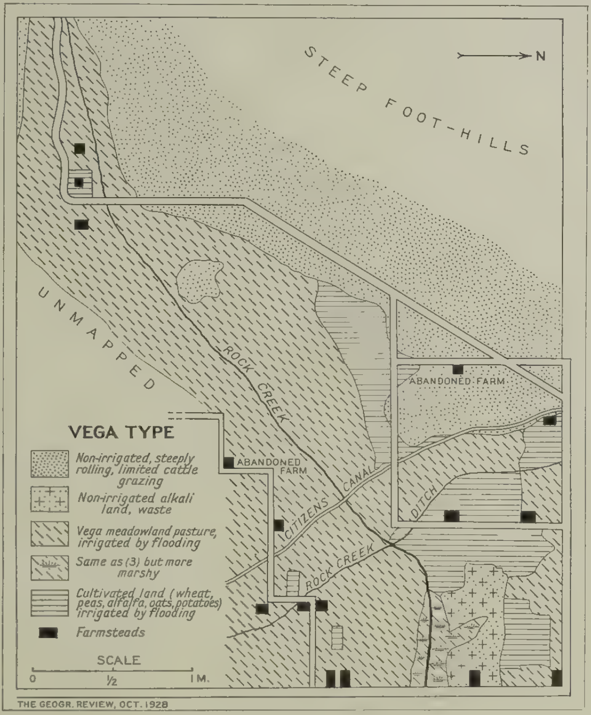
N
STEEP FOOT-HILLS
UNMAPPED
ROCK CREEK
ABANDONED FARM
ABANDONED FARM
CITIZENS CANAL
DITCH
ROCK CREEK
VEGA TYPE
Non-irrigated, steeply rolling, limited cattle grazing
Non-irrigated alkali land, waste
Vega meadowland pasture, irrigated by flooding
Same as (3) but more marshy
Cultivated land (wheat, peas, alfalfa, oats, potatoes) irrigated by flooding
Farmsteads
SCALE
0
½
1 M.
THE GEOGR. REVIEW, OCT. 1928

FIG. 9—Land utilization in the Vegas.

The use of flood irrigation is determined by two local conditions: the nearness of the water table to the surface, and the nature of the soil, a dense, sticky, plastic, black loam about two feet in depth underlain by sands and gravels interstratified with clay beds to indefinite depths. The condition of underdrainage, to which flood irrigation is in large measure a response, results from the position of the clay beds which do not maintain so steep a slope as does the surface of the fan. The successive truncation of water-bearing strata has made alkali an imminent danger; the water brought to the surface and evaporated leaves behind the salts gathered from the higher portions of the fan. Flood irrigation is a corrective of this condition since, by carrying the mineral load back to the "sub" (to use a local term) with which it drains farther down the slope, it reverses the process of alkali accumulation. The dense character of the deep Rio Grande loam also prohibits subirrigation.

The Vega farm is principally a wintering place for live stock. Closeness to the Rio Grande National Forest in the San Juan Mountains has made it possible for the farmer to maintain more cattle and sheep than the hay reaped from his three or four hundred acres of land will provide for. In early summer the larger proportion of the stock is driven or taken by stock train to high mountain pastures and then in September is driven to the old mining town of Creede where a portion is sold to stock traders.

The Seep Lands

The Seep Lands, next to be settled, lie several miles to the east of the town. Before reclamation they were typical of by far the greater portion of the western San Luis Valley. The flat surface, sloping imperceptibly to the east and locally broken by small mounds of wind-blown sand, is scantily clad with bunches of chico bush, spreading, woody brushes which rise hip-high between the twisting paths of dry and crusty earth. The soil itself, a light sandy loam, is liberally sprinkled with rounded stones.

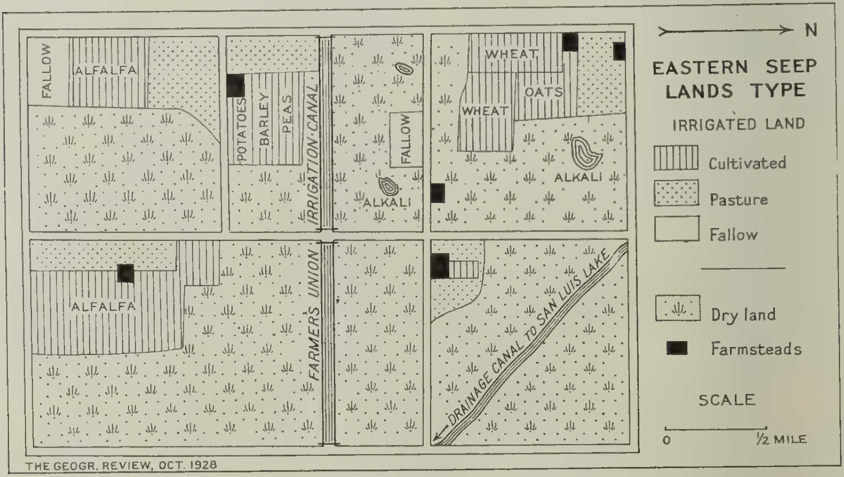

Fig. 10—Land utilization in the eastern Seep Lands.

These lands, high above the Rio Grande and stretching miles from it, defied close utilization during the pioneer stage of development; but by 1880 the construction of large canals for irrigation was begun. The vast Rio Grande Canal with headgates at Del Norte, appropriating nearly a thousand cubic feet of water, was followed by the Citizens' Ditch, the Empire Canal, the San Luis, the Prairie Canal, and the Farmers' Union, making a total appropriation of over two thousand cubic feet.

Something like a boom followed in the parts of the fan watered by these canals, about twenty miles from the mountains where the soil was relatively free of stones. Wheat was raised almost exclusively. Phenomenal yields were reported and substantiated. Rapid reclamation of land from the desert was stimulated by the canal companies, together with homestead and desert entry.

Another variety of irrigation, called here subirrigation, was developed as a result of the greater depth of the ground water and the shortage of labor. An excessive amount of water is required to perform subirrigation; that is for raising the "sub," which may be twenty-five feet below the surface, to the level of plant roots. In order thus to make the water level conform to the slope of the surface for great distances much additional water is introduced to the subterranean drainage. This water working down the slope appeared at the surface in the lower parts of the fan, a condition which was hailed with joy for several years because such moistened land grew crops without irrigation.

The excess water, however, brought with it two results which swiftly changed joy to consternation (Fig. 5). Waterlogging of the soil was followed by increased alkali accumulation through its concentration in the Seep Lands from all the fields above. In the elevated places the soil became encrusted with salt, while in the hollows briny flats formed.

Abandonment and partial abandonment took place. The present stage in the economy of the Seep Lands is one of correcting the mistakes of the past by the institution of drainage districts and the practice of flood irrigation. Already in some of the affected areas covered wooden drains lead the water to open ditches, which return it to the Rio Grande to be used for irrigation. One of the most recent drainage districts is designed to lead the surplus water to the San Luis Lake, a natural sump in the eastern part of the valley. In the summer of 1927 this open drainage canal was in process of dredging.

Although much of the land is still in use, the larger part, formerly the cream of agricultural land in this region, has so completely returned to its natural state of plains grassland that the only evidences of its former utilization are the ruins of buildings, here and there an artesian well, and the dry ditches over which one occasionally stumbles.

THE HIGH LANDS

Land utilization has reached its highest levels in the fan slopes to the north of Monte Vista. Here is produced the greater part of the surplus crops of the region; here land values and rents are at the highest figure, the best farm equipment is used, and a high standard of living is maintained. Indeed, it is in this part of the reclaimed desert that the rural Middle West is most nearly reproduced.

Farms a full section in size are not uncommon, the average being nearly four hundred acres. The management of such a large unit area is made possible by subirrigation in the cultivation of peas, potatoes, alfalfa, barley, oats, and wheat. Considerable grassland is also watered for pasture, but the High Land utilization is chiefly one of cultivation and represents the more recent developments in the region.

The potato, distinctly the cash crop of the High Lands, adjusts itself to the limited growing season and to the relatively cool nights, develops well in the light soil under the artificial control of water, and is remarkably free from pests. In the irrigation of the potato as well as of other crops, conditions are normally aided by a maximum spring and early summer rainfall, exactly half of the year's moisture falling from May to August. The timely spring rains make plowing a less difficult task and also raise the "sub" so that less ditch water is required for this purpose. It is in the occasional year when spring rains are few that great drains are made on the Rio Grande. If in addition the preceding winter has brought light snow in the mountains, ditches with late rights run low early in the season and those with water to sell reap large rewards. This combination of circumstances may be expected once in a dozen years.

The sorting and bagging of the potatoes, which necessitates hand labor—partly as a result of the many stones about the size of potatoes—is performed by Mexican families which drive into the region in covered wagons from Old and New Mexico and disappear in an equally unheralded fashion when the harvest is over. The production of about seven thousand carloads of potatoes yearly has so severely taxed the limited transportation facilities available that a large portion of the crop must be stored during the cold months. This difficulty has been met by the potato cellar, called such even though it is built above ground to avoid moisture. The three-foot adobe walls and sod roof are quite perfectly adjusted to the absolute winter night temperature of −30° F.

Field peas, which constitute a larger percentage of the cultivated crops than do the potatoes, are used to finish lambs for market and are thus a response to sheep-herding in the mountains and to the short growing season. In the autumn, lambs bought at Creede are corralled in the pea fields to harvest the crop and fertilize the ground for another season and at the same time increase the value of the meat. Hogs are also prepared for market in this way.

MONTE VISTA, THE TRADE CENTER

Today the town of Monte Vista has the prosaic appearance of a trading community. Its functional capacity is clearly shown in urban land specialization, with especial emphasis upon the type of activity in the limited manufactural area, the character of the relatively large commercial district, and the imperceptible merging of town and rural land utilization.

Of the two manufactural activities of Monte Vista the milling of spring wheat, brought from the surrounding country in motor trucks and by rail from even as far as the San Juan Basin, is by far the more important. Largely an adjustment to remoteness, it typifies the region in that the majority of the daily output of two hundred bags of flour is marketed outside the San Luis Valley.

Exposure of the seven-thousand-foot-high piedmont plain to strong diurnal winds which have whipped its eastward-sloping sandy surface into pits and mounds has induced the manufacture of grading machines in Monte Vista. These implements, called "fresnos," aid in restoring the smooth surface of the plain preparatory to its irrigation.

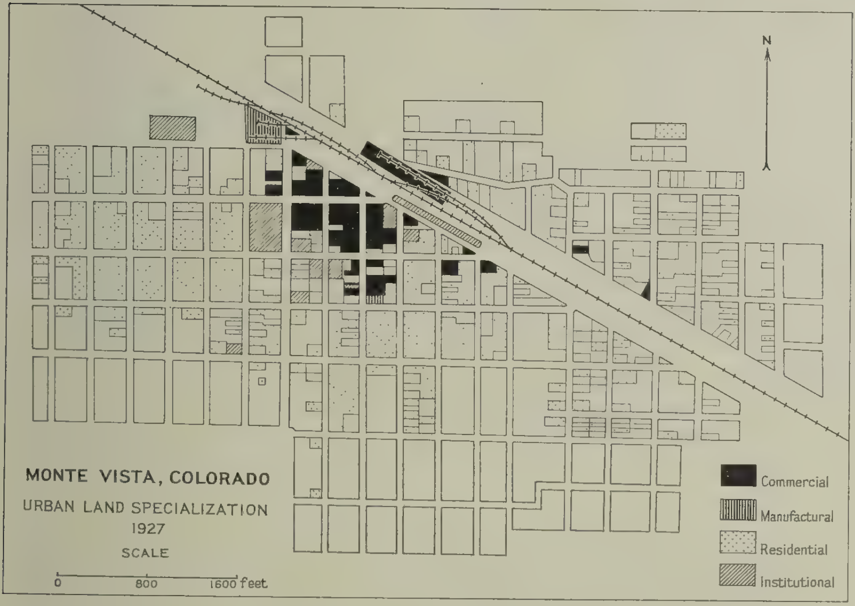

FIG. 11—Land utilization map of the town of Monte Vista.

Worthy of note in the commercial area are: a section called "Potato Row," comprising the offices of dealers in potatoes and burlap bags, whose ranks are augmented in October and November by about thirty-five additional buyers; two potato warehouses near the tracks of the Denver and Rio Grande Western Railroad, two coal yards which distribute fuel received from three distant coal fields in Colorado (Walsenburg, San Juan Basin, and Crested Butte); offices of irrigation companies and of civil engineers at present largely engaged in drainage problems; and various other businesses from traders in sheep and wool and other live stock, dealers in fur and hides, and assemblers of agricultural implements, to those of local interest, the greater part of whose trade is derived from a twenty-mile radius of the town. In the summer season there is further activity arising from the tourist travel directed toward the San Juan Mountains and Mesa Verde National Park.

Nature, so niggardly with surface water, seeks to compensate with a bountiful underground supply so that artesian wells take the place of municipal waterworks.[3] A well is drilled to a depth of about one hundred feet, bringing the water to a sufficient height above the ground to run a hydraulic ram which, in turn, forces water into and through the house. At the present time the water is allowed to run continuously, and that which is not used either aids in the irrigation of the garden with which nearly every home is provided or flows into one of the irrigation ditches which thread the town. This water, maintaining a constant low temperature in summer as well as in winter, has reduced the demand for ice to a low point. Fire protection is provided by deep-dug wells at frequent intervals; the water draining into them is forced by pumps to a sufficient height to protect the low buildings of the town.

The mask of sameness that characterizes the American town is broken here in certain particulars. Areas with poor drainage resulting from a high water table, especially to be avoided here because of the consequent alkali accumulations, have been relegated to inferior uses. This is notably the case in the Lariat subdivision, a region of Mexican dwellings made of local adobe soil, squat and picturesque but comfortless.

On the numerous country roads crossing the featureless plain along section lines, the chief expense of grading has been the necessity of crowning above the limit of ground water. The typical road of this locality, long and straight and lined on either side by deep ditches containing stagnant drainage water, stretches endlessly before one. In winter there is no snow to handicap road travel, the small amount that falls soon evaporating or melting where exposed to the bright sun. Favorable conditions of winter travel have made the consolidated school more than ordinarily feasible here. The selection of Monte Vista as a site for one of the four schools of Rio Grande County has resulted in prominently identifying the town as the educational center of its locality as well as its economic focal point. This has measurably aided in furthering the unity of the Monte Vista region.

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[3] See C. E. Siebenthal: Geology and Water Resources of the San Luis Valley, Colorado, *U. S. Geol. Survey Water-Supply Paper 240*, Washington, 1910.

THE GEOGRAPHICAL RELATION OF SOIL EROSION TO LAND PRODUCTIVITY

Hugh Hammond Bennett

U. S. Bureau of Chemistry and Soils

SOIL erosion is the greatest single menace confronting the physical side of land utilization in this country.[1] That we have had at our disposal tremendous areas of fine agricultural lands and have employed these for the production of enormous crops, and shall continue so to employ them for a long time to come, does not alter the situation or make it any less menacing, regardless of the soothing complacency found in the annual outturn of our expansive fields. The nation is not at the moment suffering from any land shortage, and we are not on the verge of starving as the result of wholesale wastage of soil productivity by unrestrained erosion.

Nevertheless, the problem is an exceedingly serious one and will surely become increasingly so under the prevailing inactive attitude of most farmers in relation toward it, that is to say, of doing little or nothing to check it and much to accentuate its evil effects. Already thousands of farmers have moved to town or to other farms because of the impoverishing effect of soil erosion, and a very large total area of land has been abandoned, in so far as cultivation is concerned. Little of the abandonment took place before the topsoil had been washed off or the fields riddled with gullies. The area thus abandoned is being increased every year and probably at a much faster rate than soil recuperation is taking place in the older abandoned areas now covered or partly covered with vegetation. The writer ventures the opinion that between 40 and 50 per cent of the land now in tilled crops in this country has suffered in some degree from soil erosion and that about one-fourth of this has suffered seriously, that is to the extent either of materially reduced yields or of requiring markedly increased soil management efficiency to maintain the yields.

PLANT-FOOD WASTAGE: SOME PERTINENT ESTIMATES

With the information available, meager as it is, it is yet possible to make rough minimum estimates of erosional wastage. If we use as a basis of calculation 500 million tons of the 513 million tons of suspended matter annually transported to tidewater by the rivers of the United

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[1] See also H. H. Bennett and W. R. Chapline: Soil Erosion a National Menace, *U. S. Dept. of Agric. Circular No. 33*, Washington, 1928.

States,[2] together with twice this amount of material removed from fields and pastures but stranded en route to the sea, it is found that at least 126 billion pounds of available and potential plant food, as well as the soil containing the plant food, are taken out of the fields and pastures of the nation every year. This figure is based upon the average chemical composition of 89 samples of surface soils collected throughout the country. That it is a minimum calculation is obvious to those familiar with field conditions. There is no doubt whatever that the amount of soil material annually stranded upon lower slopes, over

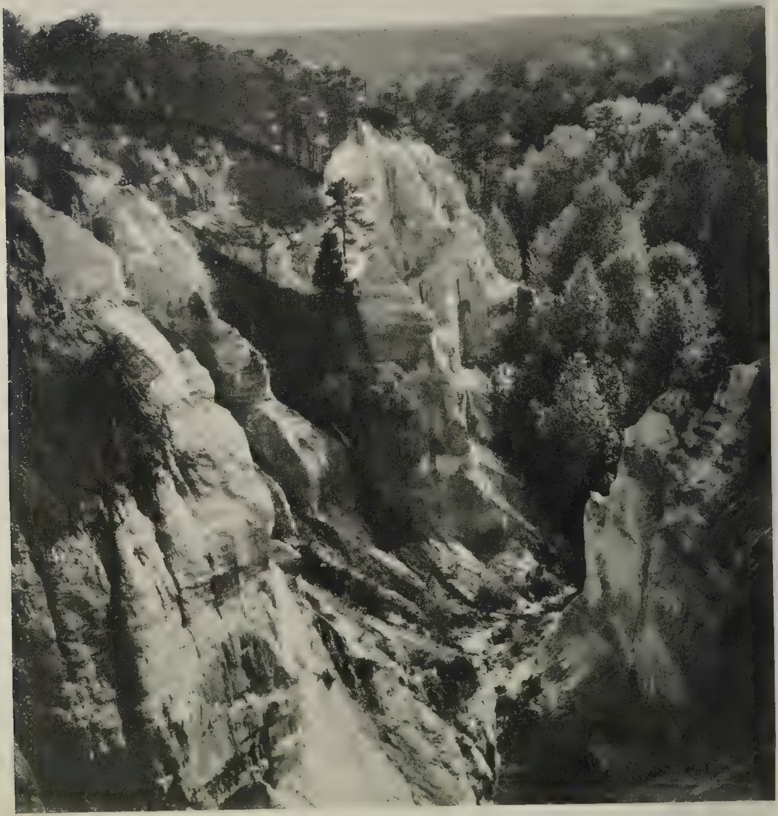

FIG. 1—This former excellent farm land in Georgia (Greenville sandy loam type) has been permanently destroyed by gullying, as the result of a wash which had its beginning from the drip off the eaves of a barn. (Photograph by Division of Agricultural Engineering, Bureau of Public Roads.)

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[2] As estimated by R. B. Dole and H. Stabler: Denudation, *U. S. Geol. Survey Water-Supply Paper 234*, Washington, 1909, pp. 78–93.

stream flood plains, and in reservoirs and stream channels is vastly greater than the amount that actually enters the oceans every year; probably it exceeds that going into the sea by more than a hundred times. Furthermore, the estimate given above does not include the 270 million tons of dissolved matter annually lost to tidewater, much of which comes from the soil. Nor does it include the drag material, the coarser particles, swept along the bottoms of the rivers. Again, there is reason to believe the determinations of the amount of material carried in suspension are too small, since they are based upon measurements of the surface water, not deeper than two feet, in the case of the Mississippi River, which carries by far the greater part of the material going out to sea.

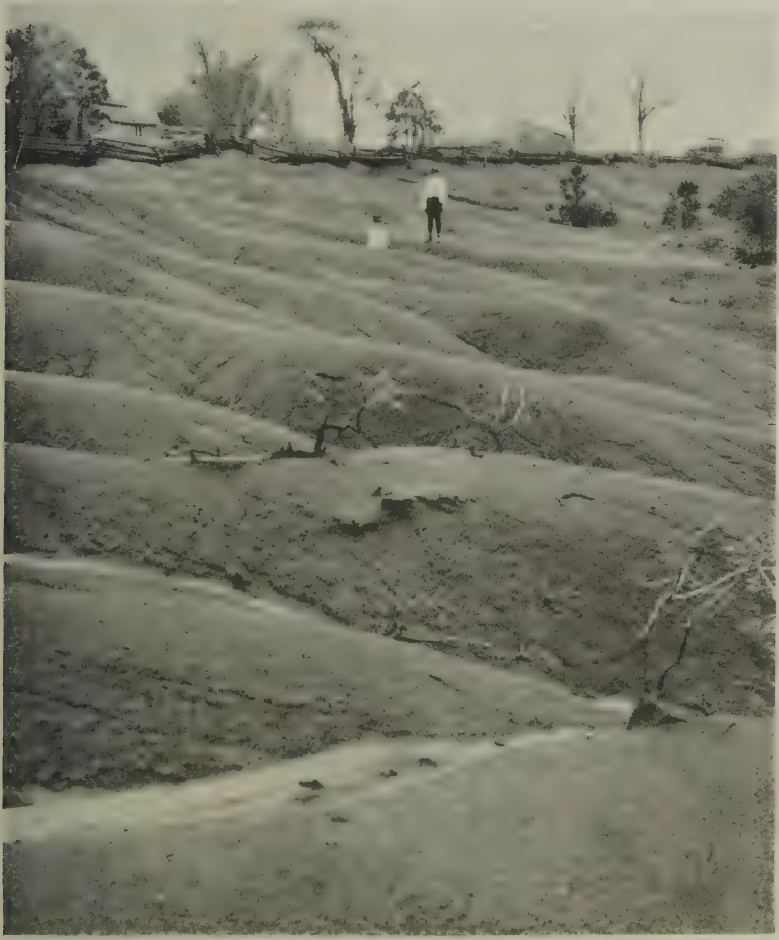

FIG. 2—This land should never have been plowed. The soil, originally Susquehanna fine sandy loam, washes excessively on steep slopes. Here the former subsoil is now the soil and is valueless.

Even the plant food contained in this minimum of material exceeds the annual net loss of plant food in the crops removed by twenty-one times.[3] Crops remove only the plant food, which can be restored; whereas erosion removes not only the plant food but the whole soil, which cannot be restored.

Since the greater part of the wastage is the work of sheet erosion, the bulk of the material comes from the surface soil, the most productive part of the land. In terms of money value for the estimated amount of material removed it is impossible to reach any very definite conclusion, since a variety of pertinent complications, chiefly bad ones, follow in the wake of erosion. When the mellow topsoil is gone, stiffer and less productive subsoil material generally takes its place, that is, where still more unfavorable gravel, sand, and loose rotten rock are not exposed; and this is more difficult to till, although needing more efficient tillage. In dry times when it is most needed by crops it is less absorptive of moisture and less retentive of that which is absorbed; and the contained plant nutrients are not so readily available. This necessitates more liberal use of fertilizers, manure or soil-improving crops, and often lime. The farmer must deal with all of these obstacles in order to maintain his acre yields, or else abandon the land to grass and trees or, as more frequently happens, to useless brush and weeds.

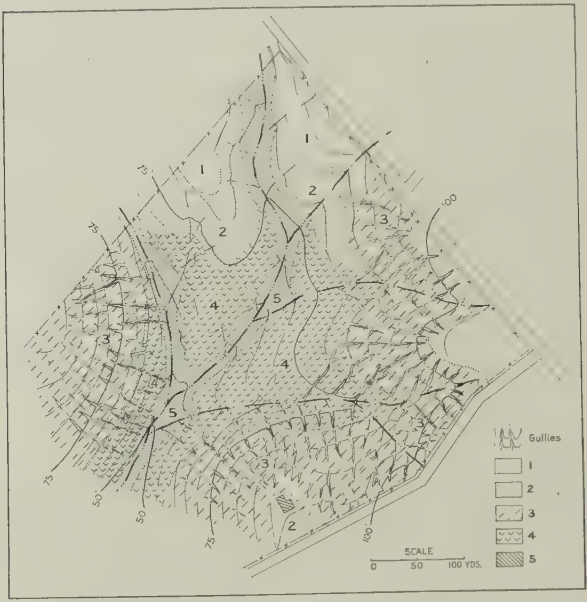

FIG. 3—Soil impairment by erosion, Granitic Piedmont, Orange County, Virginia. 1, only slightly eroded: good Cecil fine sandy loam, with eight or ten inches of soil; 2, washed until only two to five inches of soil is left: poor, eroded Cecil fine sandy loam; 3, all soil washed off down to clay subsoil; numerous gullies; useful for trees only; 4, both soil and subsoil largely washed off to rock: mainly useless land; 5, stream alluvium formed of local erosional débris: forest and meadow land. (Surveyed by B. H. Hendrickson, Bureau of Chemistry and Soils, 1927.)

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[3] Annual net loss of plant food for the United States by crops removed has been estimated at 2,900,000 tons (The Condition of Agriculture in the United States and Measures for Its Improvement: A Report by the Business Men's Commission on Agriculture, published jointly by the National Industrial Conference Board and the Chamber of Commerce of the United States, Washington, 1927, p. 106).

Calculating the value of the phosphorus, potash, and nitrogen contained in the material stripped from the fields by erosion, in the minimum estimate given above, on the basis of the cheapest commercial fertilizer that carries these nutrients, we arrive at a money valuation of approximately two billion dollars. For obvious reasons not all of this can be charged up as a direct tangible loss to the farmers of the nation; but there is evidence that about two hundred million dollars of it is a yearly tangible loss.

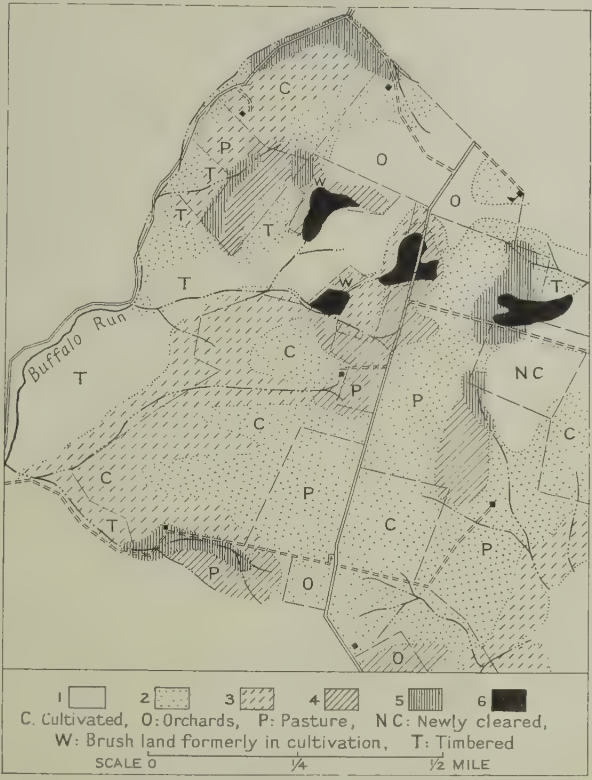
C
O
P
T
W
NC
Buffalo Run
1 ☐ 2 ▨ 3 ▨ 4 ▨ 5 ▥ 6 ■
C. Cultivated, O: Orchards, P: Pasture, NC: Newly cleared,
W: Brush land formerly in cultivation, T: Timbered
SCALE 0 ¼ ½ MILE

FIG. 4—Soil impairment by sheet erosion on comparatively smooth Appalachian Plateau, Hampshire County, West Virginia. Numbers have reference to amount of topsoil removed: 1, uneroded or only slightly eroded; 2, 20 to 30 per cent removed; 3, 30 to 40 per cent; 4, 40 to 50 per cent; 5, 50 to 75 per cent; 6, all topsoil removed. (Surveyed by B. H. Williams, Bureau of Chemistry and Soils, 1927.)

Probably not less than ten million acres of land formerly cultivated in this country have been permanently ruined by soil erosion, in so far as having value for cultivation, and an additional three million acres of good stream alluvium have been rendered valueless or have been severely impaired as a result of overwash of comparatively inert sand and gravel and increased swampiness due to choked stream channels. Half or more of the former productive bottom lands along the streams of the southern Piedmont have been made unfit for cultivation, and countless strips of alluvial soil through the Ozarks region have been buried with gravel on farms, where, in many instances, most of the arable land was that along the streams.

But this kind of land destruction and impairment represents but a small part of the damage done. The great wastage has been that which has effected partial or complete removal of the more productive surface soil by the less spectacular phase of erosion known as sheet erosion.

The damage that has been done and continues to be done by this process cannot be calculated. The worst aspect of the situation is that since the less absorptive subsoil layers are more erosive than was the more absorptive soil layer, now gone and going over immense areas, we really stand upon the threshold of unthinkable erosional wastage, if present practices continue.

Lack of Quantitative Data

The qualitative aspect of the soil erosion problem is obvious enough and has frequently been discussed,[4] but it is rather disheartening that at this stage of our development we have accumulated in this country what amounts to almost nothing in the way of the quantitative data necessary for its intelligent solution. Only three stations for studying the problem have thus far been established, and these only recently. They are located at Spur in western Texas, at Columbia, Mo., and in the Piedmont region near Raleigh, N. C.

The problem of soil erosion is complex, for the process is exceedingly variable in its effectiveness from place to place, on varying soil and slope, with varying vegetative cover, type of land usage, and character of precipitation. The average depths of surface denudation that have been computed from river discharges alone mean very little. They imply that the surface everywhere, on steep hillsides and flat prairies, on sand dunes and loam and clay and silt, is being planed down at an equal rate. The statement we so often read that the surface of the vast Mississippi Basin is being lowered by erosion at the almost insignificant rate of .0028 of an inch annually is not only too small as an average but, since erosion does not operate according to any fixed plan of averages, is meaningless and dangerous for its complacency. In this paper illustrations will be given of the process at work under varying conditions, these illustrations being largely taken from the writer's own field work.

Some Measurements in the Field

At Spur, Tex., 40 tons of soil material were removed from one acre of bare land, with a two per cent slope, by 27 inches of rain. From one acre, with nine per cent slope, in the Piedmont of North Carolina, 25 tons were removed by 36 inches of rainfall. On another soil of approximately four per cent slope in central Missouri, the Shelby loam,[5] 41 tons were lost per acre per year, with 36 inches of rain, on bare ground tilled four inches deep.

From grassland in North Carolina, the rate of erosion was 415 times

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[4] For a recent statement see W. C. Lowdermilk and J. Russell Smith: Notes on the Problem of Field Erosion, *Geogr. Rev.*, Vol. 17, 1927, pp. 226–235.

[5] For description of the Shelby soils, and other soil types subsequently referred to, see H. H. Bennett: The Soils and Agriculture of the Southern States, New York, 1921.

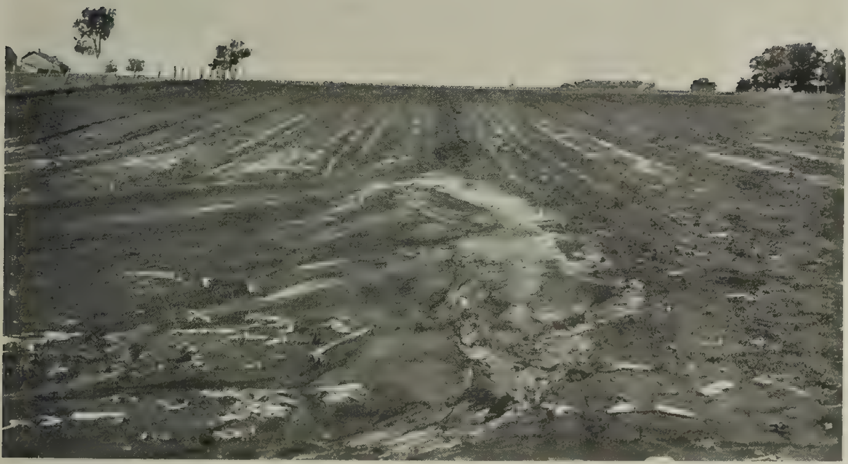

FIG. 5

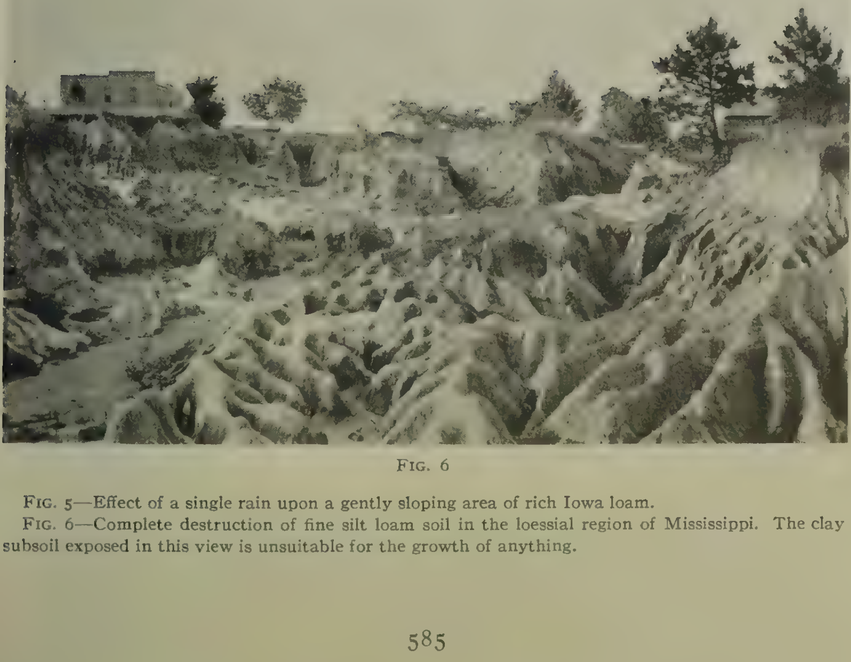

FIG. 6

FIG. 5—Effect of a single rain upon a gently sloping area of rich Iowa loam.

FIG. 6—Complete destruction of fine silt loam soil in the loessial region of Mississippi. The clay subsoil exposed in this view is unsuitable for the growth of anything.

slower than on bare ground of the same slope and soil; while at the Missouri station the rate of wash-off from sod land was 137 times slower than from bare ground plowed four inches deep. In the latter instance the rate of wearage for bare ground was seven inches in 24 years, and for blue-grass sod seven inches in 3547 years. Grass proves not only highly efficient in restraining soil erosion but also in conserving rain water. In Texas grassland held back 82 per cent of the rainfall, at least temporarily; whereas only 55 per cent was retained in cotton fields. In Missouri grass retained 88 per cent of the rains, and shallow-tilled, bare ground only 69 per cent; in North Carolina grass caused 98.5 per cent of the precipitation to remain on the land, whereas only 65 per cent of it remained on bare ground.

Such data are indicative of what has been taking place on the sloping areas of the Mississippi Basin since the breaking of the vast mat of sod that originally covered the prairies of that region. They are suggestive also of the powerful restraint exerted by forests upon the wash-off and run-off; for much of the land concerned was originally timbered, and trees, like grass, hold back both soil and water.

If grass sod in the Piedmont enables an important agricultural type of that region to hold back 51 per cent more of the rainfall than bare ground, and 33 per cent more than fields planted to cotton, what saving are we to expect from a well-forested area with a good ground cover of woods mold consisting essentially of peat, knowing that some forms of peat are capable of holding water in excess of a hundred times their own weight? That we do not have an abundance of measured data of this nature for our key soil types, proves the pressing necessity for research in this field.

Factors Affecting Soil Erosion

Soil erosion[6] has been going on undoubtedly since the first rain that followed the development of the first film of soil. We are not especially concerned here about natural or normal erosion, since it is largely unpreventable[7] and, as a rule, does no great damage to the land. It is abnormal erosion that we are concerned with: that excessive washing of the soil which is due to removal or impairment of the vegetative cover and to physical disturbances of the ground, as a result of land clearing, grazing, fires, plowing, ditching, etc., most of which is the direct or indirect result of man's activities, chiefly his unwise methods of using the land.

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[6] This paper is concerned with water erosion. Wind erosion functions in a manner quite similar to water erosion and does a vast amount of damage. It is a major phase of erosion, however, and will be treated in another paper.

[7] It should be noted however that there are some exceptions to this statement. It might be possible, for example, to find some shrub or vine or grass that would thrive on such wasting areas as the Bad Lands, bind the soil, and keep large quantities of silt out of the streams. And it is quite possible to check erosion along the sea coast in places.

Over large areas normal erosion proceeds at a rate that about equals the formation of soil from the rock and other parent materials. On the other hand, abnormal erosion, which we here refer to simply as *soil erosion*, usually exceeds the rate of soil formation on sloping areas, although varying in its progress with: (1) soil character, (2) character of vegetative cover, (3) degree of artificial ground modification, (4) degree of slope, and (5) climate. This order of arrangement has little to do with the relative importance of these most important erosional variants, except that soil character probably should head the list.

Climate is a very important erosional factor, as a matter of course. Hard beating rains of summer are much more destructive than the slowly-falling showers that characterize some regions. When the ground is frozen deeply or covered with a blanket of snow for long periods there can be no erosion until thawing starts the water downhill; and this, as a rule, will be a gradual process, less destructive than heavy rains. Probably the loosening effect of alternate freezing and thawing upon some soils gives a condition of porosity that makes them more resistant to erosion than similar soils of warmer latitudes. Spew frost, by lifting films of soil, effects considerable local downward movement of material on steep slopes of certain soils, when the small columns of supporting ice melt.

Most of these climatic effects are modified by soil types, usually very greatly. One of the most important points about the relation of climate to erosion is that there is erosion wherever there is enough rainfall for water to run downhill. There are some peculiar soils that absorb most of the rainfall, even clay types, no matter how heavy the precipitation; but even on these the open pore space is sometimes temporarily filled, and some of the rainfall does flow away and accomplish a small amount of surface wastage. The least erosion ever observed by the writer, the one place where there was no appreciable washing, was on a soil type that belongs to a class of highly erosive soils, that is wind-blown silt loam. In this instance, encountered on the slopes of the Tanana River below Fairbanks in northern Alaska, one and three-fourths degrees south of the Arctic Circle, the resistance to erosion is entirely climatic. The rainfall is exceedingly light, about 11.5 inches, and it falls as light showers. The soil is frozen eight or nine months, and the region has a sub-ice cap, that is, the ground is permanently congealed from depths of a few feet below the surface down to bed rock.

Indirectly, climate is closely related to soil erosion. Under certain climatic conditions, as those characterizing the humid tropics, highly percolative clays which are very nearly nonerosive,[8] have been formed under forest cover. Again, in the dry regions soils have been formed which are tremendously susceptible to erosion because of peculiar structural conditions associated with high contents of the soluble bases.

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[8] H. H. Bennett: Some Comparisons of the Properties of Humid-Tropical and Humid-Temperate American Soils, *Soil Science*, Vol. 21, 1926, pp. 349–374; H. H. Bennett and R. V. Allison: The Soils of Cuba, Tropical Plant Research Foundation, Washington, 1928.

Dole and Stabler's figures for river silt in suspension[9] reveal striking correlations between erosion, on the one hand, and soil and climate, on the other. For example, the amount of material carried in suspension by the Missouri River near its confluence with the Mississippi is 1138 parts per million; whereas the average content for three rivers of the northeastern United States, the Kennebec, Housatonic, and Hudson, is only 8.3 parts per million. The Rio Grande at El Paso carries 14,140 parts per million. The Missouri flows through a region including much highly erosive silt soil (loessial soils); the Rio Grande traverses dry country where much of the soil upon desiccation breaks down into a fluffy structure favoring rapid removal by rainwash; whereas the group of northeastern streams receive their drainage from an area largely comprising absorptive glacial till soils that are but slightly inclined to wash. The Rio Grande carries 700 parts of dissolved matter per million; the Missouri, 294 parts, and the northeastern stream group only 77.5 parts.

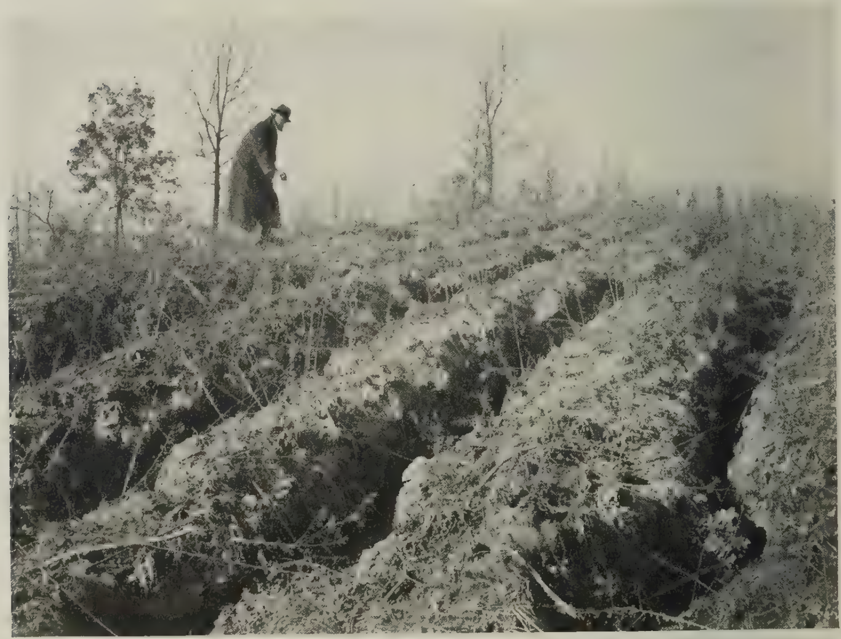

FIG. 7—Soil "mining" in the loessial region. These corn rows running up and down the hillside have well-started gullies between them. (Photograph by W. R. Mattoon, U. S. Forest Service.)

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[9] Paper cited in footnote 2.

VARIATIONS IN CLAY SOILS

Reference has already been made to the case of a two per cent slope of clay loam (Abilene) in subhumid western Texas, which showed an erosional loss of 40 tons of soil per acre with 27 inches of rainfall; whereas sandy clay loam (Cecil) in the Piedmont of North Carolina showed a loss of only 25 tons per acre from a nine per cent slope, with a precipitation of 36 inches. Considering the fact that the carrying capacity of water increases enormously with the velocity, as does also the scouring capacity, the results obtained at the Piedmont station stand out as a remarkable example of the influence of soil upon the rate of erosion. Even so, the Piedmont soils suffer greatly from rain-wash on all unprotected slopes. But for the fact that a large proportion of the soils of this region contain much highly weathered clay of a peculiar porous character, functioning as erosion-resistant material, this part of the country doubtless would have been largely washed down

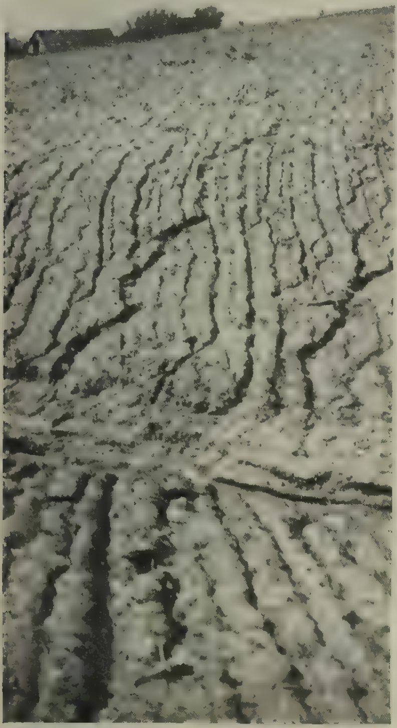

FIG. 8

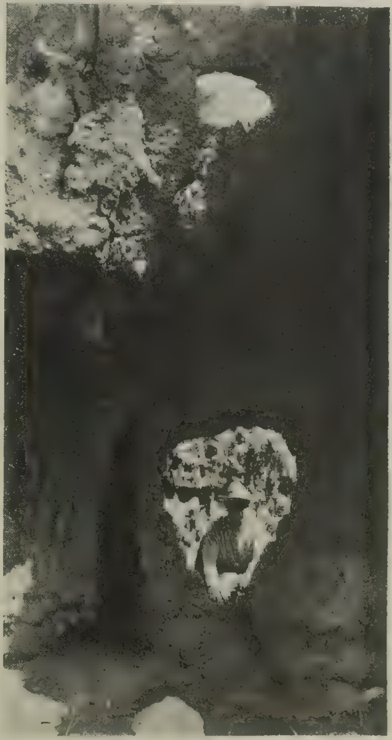

FIG. 9

FIG. 8—A field in northeastern Kansas (about twelve miles from the Missouri River) that was riddled by erosion during a single rainy spell in the fall of 1927. Some 40 tons per acre of the richest topsoil was then lost.

FIG. 9—By a peculiar soil-scaling process upon drying, the face of this gully of deep silty clay in southwest Texas has cut through into the next gully abnormally quickly.

to its bed rock long ago, as has happened in many rolling Piedmont areas of the plastic Iredell soils.

Clay land having powerful resistance to erosion is very extensive in the humid forested areas of northern California and in western Oregon and Washington, such as the Aiken clay and clay loam.[10] These lands are used on steep slopes for prunes and other fruits with very little evidence of washing, even where cultivation is carried up and down the slopes, rather than along the contours. These are tropic-like soils of low silica and high iron and alumina contents, much like those of eastern and middle Cuba.[11] As a result of recent studies within tropical regions of the western hemisphere it has been learned that certain extensive types of highly weathered clays, those having low ratios of silica to iron and alumina (a molecular ratio of less than two) are practically immune to erosion.[12]

The less weathered clays, whose products have not been highly oxidized or severely leached since the disintegration of the parent materials, show opposite properties, with respect to erosivity, to the tropic-like or highly-weathered clays. These types have relatively high contents of silica and low contents of iron and alumina (a molecular ratio greater than two).

Such impervious, plastic clays are characteristically exemplified in the extensive yellow clay soils of the Iredell series of the southern Piedmont, a derivative of basic igneous rocks; the very extensive Susquehanna soils, having mottled clay subsoils, derived from plastic clays of the Gulf Plain area, extending from west-central Georgia to central Texas; and the Lowell and Fairmont soils of the limestone areas of northern Alabama, central Tennessee, Kentucky, and southern Ohio and Indiana. In a single county of the Piedmont, 90,000 acres of land, formerly cultivated, productive soil, have been largely destroyed by gullies. This was mapped by the Soil Survey as Rough gullied land,[13] that is largely non-arable land, with a considerable part washed off to bed rock. The general appearance of the area indicates that since the survey was made, seventeen years ago, several additional thousands of acres have attained this all but desert condition. Centuries of soil building will be required to restore the land to cultivation.

In one county of the coastal plain region 70,000 acres of land, most of which was cultivated at one time, have been mapped as Rough gullied land and Susquehanna clay, now having very little or no crop value as the result of erosion.[14] Of this, 33,000 acres were classed under the latter designation and described as follows:

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[10] E. F. Torgerson, Charles Hartmann, Jr., E. J. Carpenter, and W. G. Harper: Soil Survey of Polk County, Oregon, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1922—Advance Sheets*, pp. 1681–1721.

[11] H. H. Bennett: Some Geographic Aspects of Cuban Soils, *Geogr. Rev.*, Vol. 18, 1928, pp. 62–82; reference on p. 80.

[12] Bennett and Allison, *op. cit.*, pp. 238–239; H. H. Bennett: Agriculture in Central America, *Annals Assn. of Amer. Geogrs.*, Vol.16, 1926, pp. 63–84; *loc. cit.:* Some Comparisons of the Properties of Humid-Tropical and Humid-Temperate American Soils.

[13] M. E. Carr, F. S. Welsh, G. A. Crabb, R. T. Allen, and W. C. Byers: Soil Survey of Fairfield County, South Carolina, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1911 [13th Rept.]* pp. 479–511.

> "The Susquehanna clay occupies steep slopes, the crests of rounded hills, and the tops of ridges. Erosion has so gullied the greater part of the type that there is practically no level land within its boundaries. . . .
>
> "*The rough character of this land, which prohibits tillage operations over much of it, is the result mainly of erosion which has taken place since the land was cleared for cultivation.* [The italics are the author's.] The Susquehanna clay was one of the first soil types farmed in the county. It was considered strong land and produced as much as a bale of cotton per acre without the use of fertilizers. There are today on this type many deserted but substantial farmhouses, abandonment of which was compelled by the ruining of the fields by erosion."

Of the 37,000 acres of Rough gullied land the report says:

> "Rough gullied land includes areas which, as the result of erosion, are so steep and broken as to be unfit for agriculture. . . . Some areas are available for pasture, but a considerable total area is not even suitable for this use, as there are many deep gullies with steep or perpendicular sides on which no vegetation can find a footing. Providence and Trotman "Caves," to the west and north of Lumpkin, are examples of such areas."

Until recently it had generally been supposed that all soils of high clay content were necessarily heavy, stiff, and impervious and that the sandy soils were friable and pervious. Recent studies have shown that this depends upon the kind of clay present, that is where any considerable amount of particles of clay diameter is present in the material. The low and high erosivities exhibited by the two varieties of clays discussed above are due, respectively, as well as can be determined from the accumulated evidence, to high and low degrees of flocculation[15] of the soil particles. Perhaps it would be more appropriate to define the physical condition in the latter instance as being due to a comparatively high degree of particle dispersion. At any rate the particles of these plastic clays, such as the Susquehanna and Iredell of the United States and the Bluefields[16] of eastern Nicaragua, are not flocculated soils as the term is generally understood. They are dense clays without free pore space through which water can move freely under force of gravity, and they shrink and swell violently at the extremes of moisture content. On the other hand, the group of clays having opposite characteristics have an abundance of pore space, through which water moves downward freely. Some of these clays are

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[14] D. D. Long, M. W. Beck, E. C. Hall, and W. W. Burdette: Soil Survey of Stewart County, Georgia, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1913* [*15th Rept.*], pp. 545–606.

[15] Lack of flocculation corresponds to what soil technologists commonly speak of as dispersed soil. In this state the particles stand alone as individuals. Thus unsupported they are more open to attack than the particles of flocculated soils, with their grains bound together in clusters.

[16] J. C. Treadwell, C. R. Hill, and H. H. Bennett: Possibilities for Para Rubber Production in Northern Tropical America, *U. S. Dept. of Commerce Trade Promotion Ser. No. 40*, 1926, pp. 142–143.

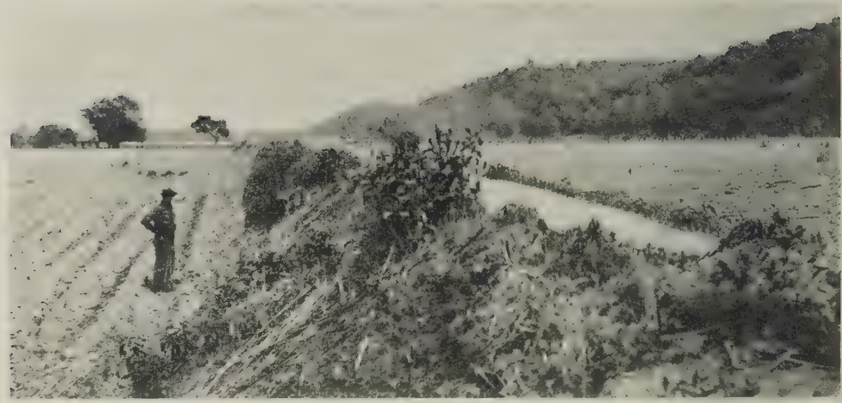

FIG. 10

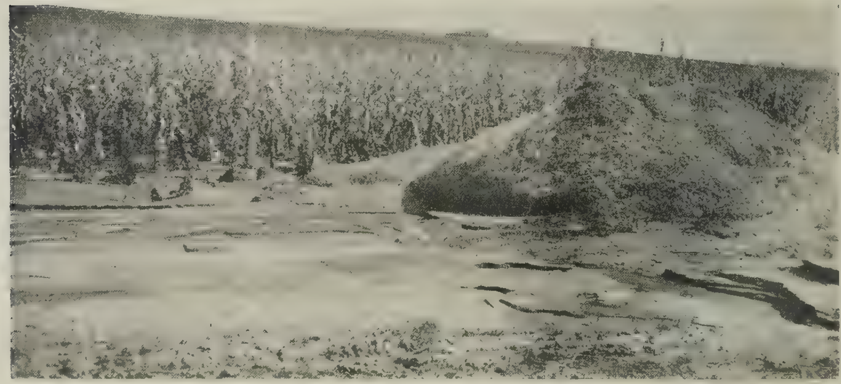

FIG. 11

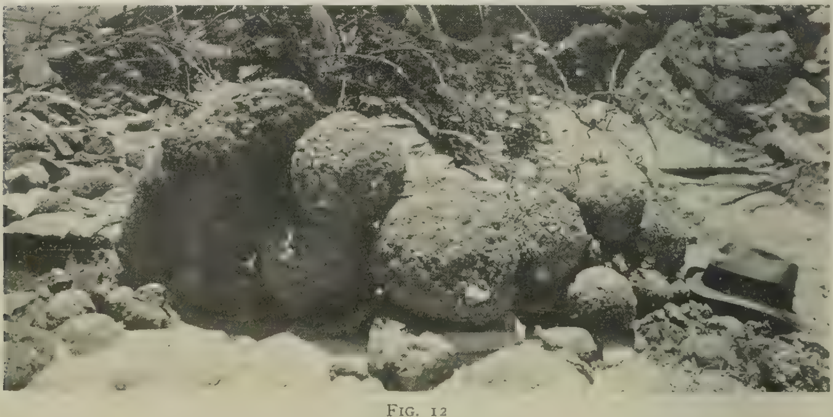

FIG. 12

FIG. 10—This dike, protecting the highly productive Missouri River bottom land, has caught eight feet of erosional débris from the uplands in ten years. The rate of deposition of a forty-acre field here was 1200 tons per acre per year.

FIG. 11—Wheat straw dumped in a depression caught 430 tons of rich soil material washed from the adjacent slopes during fall rains (northwestern Kansas).

FIG. 12—These gravel-coated clay balls, found in a southwest Texas stream bed, illustrate a curious form in which land material is being transported to the sea.

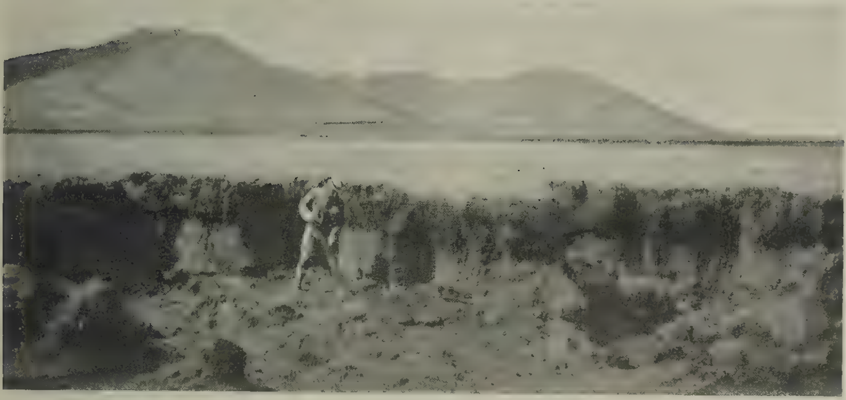

FIG. 13

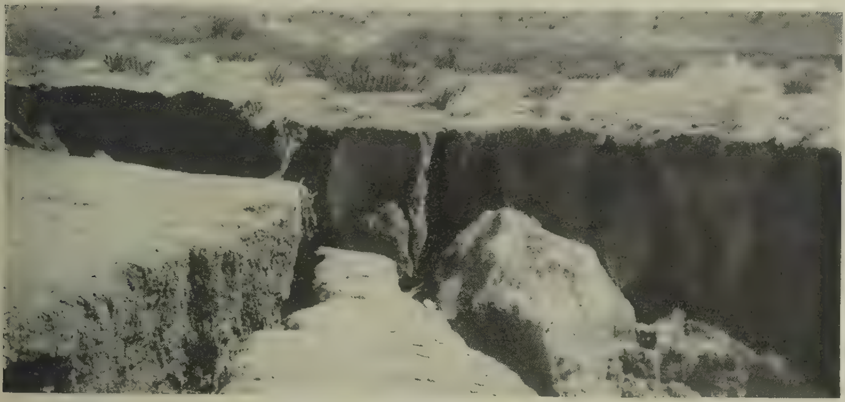

FIG. 14

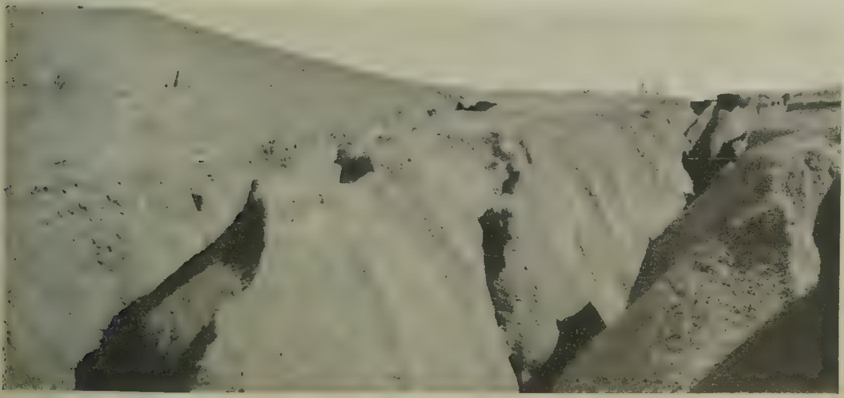

FIG. 15

FIG. 13—Excellent valley grazing land in the arid southwest being rapidly ruined by erosion which started in the bedding ground of cattle.

FIG. 14—Channel-trench erosion in the Trans-Pecos region, southwest of Valentine, Tex., 1927.

FIG. 15—This is a deep erosional gully in a formerly timbered area in northern California. The vegetative cover was largely annihilated by smelter fumes.

almost as friable as sand and take up the rainfall just as readily. They also exhibit almost negligible properties of shrinking or swelling with decrease or increase of the moisture content.

Erosion of Silt Soils in the Mississippi and Missouri Basin

The upland silt soils of the United States, including some of the most important agricultural lands of the nation, are all erosive types, some representing probably the most erosive of all soils to be found in the country. Those that are most susceptible to destructive washing, both by sheet and gully erosion, are found in the great areas of loessial soil bordering the Mississippi River on the east side from the vicinity of Baton Rouge, La., across western Mississippi and Tennessee and southwestern Kentucky and bordering also the Missouri from its confluence with the Mississippi to the boundary of South Dakota. This great area includes some of the very best upland corn soils we have, such as the Marshall silt loam; also good corn, grain, and apple soils, as the Knox silt loam; and, in the southern part, good cotton lands, as the Memphis and Granada silt loams.

That these lands wash severely is due to three principal characteristics: (1) Lack of flocculation of the silt particles, coupled possibly with incoherency resulting from a low content of binding clay; (2) the presence in the substrata of a soft silt layer; and (3) the generally rolling topography, particularly of the Memphis and Knox soils. The wastage is by a three-step process, i. e. the silty surface layer is gradually removed from unprotected slopes by sheet erosion; then gullies cut through the normal silty clay subsoil into the soft silt layer beneath; whereupon devastating dissection begins, the gullies deepening and spreading very rapidly. In some parts of the southern extension of the region the major part of the uplands of a number of counties has been ruined by erosion, and, as a consequence, farming has been largely driven into the stream bottoms. Unfortunately, many parts of the stream bottoms have been covered with comparatively inert sand assorted from flood waters, and the channels of numerous streams have been so choked with erosional débris that overflows are much more common than formerly.

While the damage has not been quite so serious there has been a considerable degree of gullying in the Missouri River belt of loessial soils and an enormous amount of sheet erosion. In the fall of 1927 the writer found from one to two feet of rich, mellow silt loam over clay in areas of virgin timber in northeastern Kansas, where over adjacent areas having the same slope and soil, cleared about 40 years ago, all of the soil had been washed off in numerous abandoned and tilled fields. In some of these a half a foot or more of the subsoil had been removed after the soil had been carried away. Indeed, bed rock was exposed in places, which originally was covered with four feet of soil material.

In some fields of the region having only moderate slope it was found that more than 40 tons of soil material per acre were removed from the Marshall and Knox silt loams as the result of a single rainy period that followed the seeding of the land to grain. The grain was mostly washed out, and the fields were riddled with miniature gullies (Fig. 8). Against a pile of wheat straw at the foot of two converging slopes 430 tons of soil material that had been washed down by the fall rains (1927) were lodged (Fig. 11).

Already in this region of exceptionally productive soils, gullied fields are being abandoned to pasture, and most of the sloping areas have been impoverished in some degree by soil wash, with many thousands of acres denuded of their productive topsoil. Apple trees are dying in a number of orchards as the result of erosion. Generally on the lower positions where some of the wash has temporarily stranded the apple trees and other crops are doing well, showing that the deterioration on the higher slopes is the result of soil removal. In one orchard the surface now stands five feet higher than the ground upon which the trees were planted.

On another farm in northeastern Kansas the operator had constructed an eight-foot dike to intercept outwash from the adjacent uplands, which was damaging his rich alluvial corn land in the Missouri River bottoms and covering his roadways. In ten years the land behind the dike had been filled in level with the dike over a 40-acre field (Fig. 10). In other words, deposition of erosional débris had taken place here at the rate of 1200 tons per acre per year.

This sort of thing is going on in many places in the bottoms of the Missouri and its tributaries. Nothing of any importance is being done in the region to slow down erosional wastage; whereas much is being done to accentuate it. Corn rows are often run up and down the slopes rather than along the contours, a practice that invariably speeds up the effects of rainwash. It is also a common practice to plow furrows down the slopes in springtime in order to drain water from between corn rows. Many of these relief furrows grow into gullies which, dividing, dissect the fields and eventually cause their abandonment to pasture or brush. Even then the washing continues for a considerable time.

An Erosion Type in the Central Coastal Plain

A number of other important types of farm land have suffered disastrously from dendritic gullying owing to the rapidity with which the incisions extend themselves when the coarser materials underlying the soils have been cut into. Some of these types, such as the valuable group of soils characterized by the Orangeburg and Greenville series of the central coastal plain region, are so susceptible to this kind of wastage that it is safe to make the statement that not one acre of them should be used for the clean-cultivated crops without protection with terraces, whenever the slope exceeds four or five per cent. It was principally on these types that 37,000 acres of former cultivated land were found by actual survey to have been destroyed in Stewart County, Georgia, in 1913, as already noted. Probably not less than half a million acres of these excellent cotton and corn soils have been permanently destroyed or temporarily made unsuitable for profitable cultivation by soil erosion.

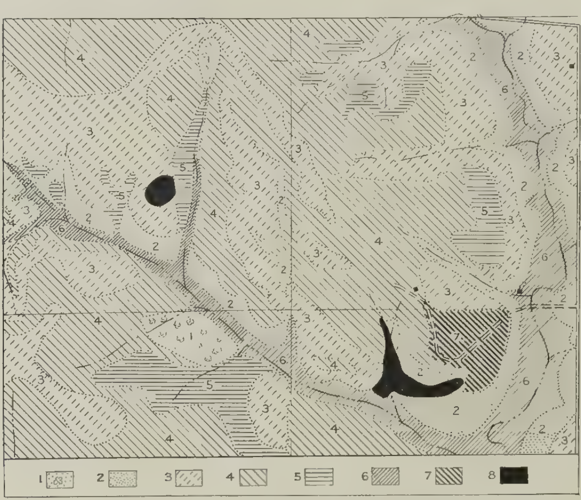

FIG. 16—Soil impairment by sheet erosion on Knox silt loam, Doniphan County, Kansas. The area represented is 120 acres. 1, virgin timber: 12 to 24 inches of dark-brown mellow silt loam, over yellow silty clay loam, uneroded soil; 2, soil washed from higher slopes: 10 to 20 inches of brown silt loam over yellow silty clay loam of previously eroded areas; 3, cultivated fields: 4 to 10 inches of light-brown silt loam over yellow silty clay loam: 8 to 14 inches of topsoil washed off; 4, cultivated fields and orchards: 2 to 4 inches of yellowish-brown heavy silt loam to silty clay loam over yellow silty clay loam; 10 to 26 inches of soil washed off; 5, steeper cultivated slopes: light-brown, silty clay loam, i. e. exposed subsoil; 12 to 30 inches of soil washed off; 6, alluvium from slopes: 15 to 30 inches of brown to dark-brown silt loam over heavier silty material; 7, yellowish-brown silty clay loam, from which all the original soil has been washed off and from 4 to 6 inches or more of the subsoil; 8, non-arable land with abundance of limestone outcrops, most of the soil removed by erosion. (Surveyed by E. W. Knobel, Bureau of Chemistry and Soils, 1927.)

When it rains the material of the loose sandy beds beneath the subsoil clay readily washes out, with the result that huge chunks of the overlying soil and subsoil topple into the gullies. Gully growth by this process is rapid, extension being fastest by the heads, which follow up minor depressions in the surface, in many places having cut through formidable ridges, even those occupied by forests.

This *head-on extension* type of deep gully erosion can be controlled economically only by stopping the washes before they have cut down into the unstable substrata.

EROSION IN THE DRIER REGIONS

It would be reasonable to assume that in the dry regions of the West, where precipitation is often less than ten or twelve inches annually, soil erosion is far less active than in the humid regions. Such is not the case, however, at least for numerous localities, where structural soil features and scantiness of vegetation contribute immensely to the wastage.

In the Trans-Pecos region of Texas and in central New Mexico a great deal of exceedingly destructive erosion is to be seen. Even over smooth areas occupied by valley-filling material, representing the accumulation of centuries, the soil has been bodily swept away or cut to pieces by a type of erosion that has been referred to as channel-trench erosion.[17]

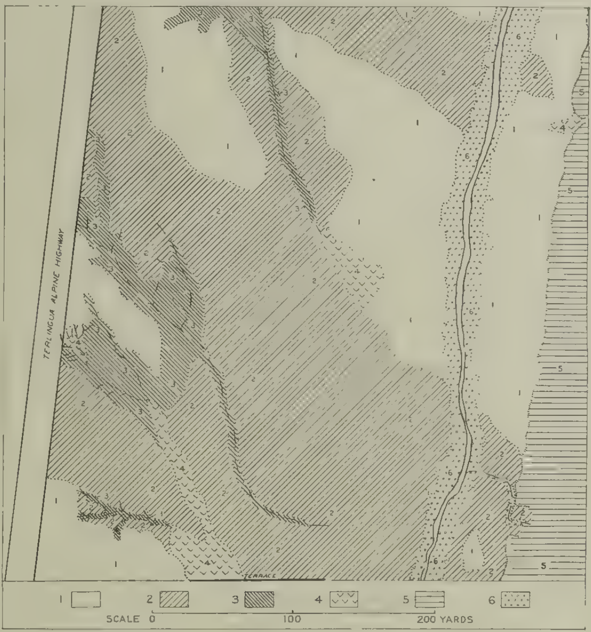

FIG. 17—Soil impairment by channel-trench and dry-climate-sheet erosion, southwestern Brewster County, Texas. 1, uneroded, or only slightly eroded: good Marfa clay loam; 2, half or more of topsoil removed: Marfa clay loam; 3, all soil and much of subsoil removed: severely dissected Marfa clay loam of low value; 4, accumulated erosional débris: silty clay loam, good soil; 5, upland: Brewster stony loam; 6, stream gravel. (Surveyed by M. W. Beck, Bureau of Chemistry and Soils, and T. C. Reitch, Texas Agric. Exper. Station, 1927.)

The writer saw last year (1927) literally hundreds of places where former valuable grazing areas had suffered from various phases of this type of wastage, to degrees varying from moderate impairment of the land to its absolute destruction. All of the eroded areas studied in this region had their beginning in roadways, cattle trails or bedding grounds, prairie-dog towns, or diversion ditches. The washing, in other words, had its start in those situations where the grass cover and ground equilibrium had been seriously disturbed. Structural peculiarities of the soil and, in places, coarse-textured basal material had contributed vastly to the rapidity of the erosion. As a matter of fact, the tendency of many dry-region soils to crack and recrack on drying, thus to form a loose fine-fragmental or granular surface layer, adds greatly to the erosional vulnerability of tremendous areas of the lands. This applies not only to desert soils but to subhumid types.

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[17] Kirk Bryan: Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest, *Science*, No. 1607, Vol. 62, 1925, pp. 338–348.

At Spur, Tex., for instance, on a two per cent slope 40 tons of soil were washed from one acre by 27 inches of rainfall, in a locality whose average annual precipitation amounts to 22.55, the minimum to 10.92 inches and the maximum to 35.61 inches. With heavy rains the chafflike soil is swept before rushing water as so much litter; then, with saturation, the emulsified mass flows rapidly down the slopes. Under the influence of this process enormous quantities of soil are swept into the streams and upon lower positions where it is not needed.

Another effect of dry-land soil structure is to assist erosion in a bi-active rôle. This is the common tendency of the heavier soils to split or crack vertically so as to develop a columnar structure. Washes begin in the fissures in some instances; and from the sides of gullies a splitting-off process, accompanying desiccation of the material, causes comparatively rapid wearage upon the exposed faces. This aids one gully to wear through to another much quicker than would happen in humid regions (Fig. 9).

In 1925 six square miles of the watershed of a stream near Redlands, Cal., were burned over; the following year 11 inches of rain falling upon the watershed in three days eroded the burned-over area and cut into the bed and stream banks of the valley, transporting and spreading débris over the lower valley floor, planted to oranges, to a distance of one and a half miles out from the point of debouchment of the valley from the highlands. The depth of this covering of loose, unfavorable gravel, sand, and silt ranged from a mere film to two feet through the groves. Where the depth ranged from six inches to a foot it proved necessary to dig the material away from the base of the trees. Where it exceeded a foot the orange trees began to die, and it was necessary to remove the detritus with the assistance of a steam shovel. It is said to have cost 60 cents a cubic yard to haul the material out of the grove, the average cost amounting to $1200 an acre. The expense of this operation was estimated to approximate the value of the land, and it is doubtful if the owners could afford to remove a second such deposit, even from the valuable orange groves.

A notable instance of destructive erosion following the removal of the vegetation from forest land by smelter fumes was observed last year in Shasta County, California, at Kennet. Here the vegetation was completely obliterated or very largely destroyed by fumes from a copper smelter over an area estimated as exceeding a hundred square miles. The original growth consisted of pine, live and deciduous oak, together with chaparral of manzanita, coffee berry, poison oak, etc., and the soil was a gravelly clay or clay loam. Partial rock decay had extended to depths of probably more than a hundred feet in places. On this hilly to mountainous area erosion has wrought unbelievable devastation. Deep, narrow gullies have riddled the affected area. Some of the trench incisions, with an estimated depth of 50 feet, wander about like glacier crevasses; others spread widely in dendritic fashion. The soil is completely gone, and with it every vestige of forest mold. It will be interesting to watch the rejuvenation of this devastated area, by encroaching vegetation, now that the smelter has moved; that is if rejuvenation takes place before the decomposed material has largely washed down to bed rock.

And finally it should be noted that though its greatest damage is taking place over certain large critical areas—the Piedmont, the upper coastal plain, the loessial region, the region of shale soils in the Appalachians, the regions having rolling soils with plastic clay subsoils, the heavy lands of the dry Southwest, and the overgrazed sheep lands in parts of Utah and other western states—this must not be construed as meaning that erosional wastage is not going on elsewhere. As a matter of fact, land impairment is proceeding in many places where its activity has not been suspected by the average farmer, even on soils that seem nearly flat.

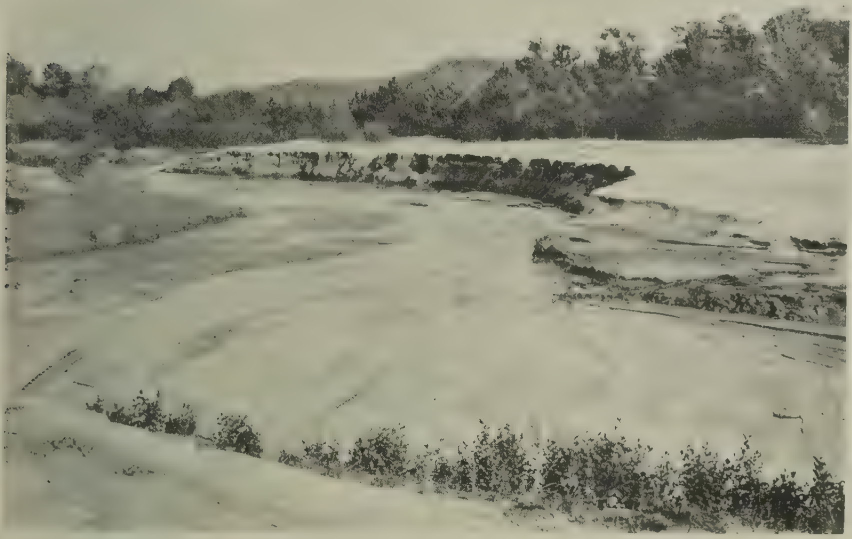

FIG. 18—Along this stream twenty feet of alluvial material was deposited in fifteen years, and the land was rendered practically valueless.

RELATION OF EROSIONAL SEDIMENTS TO FERTILITY

A word should be said regarding the reverse of the erosional process. It is commonly believed that the products of erosion largely go to improve the alluvial plains over which part of the material is deposited in times of flood. From this angle of viewing the situation it is sometimes contended that floods are of great value, serving as a powerful instrument for soil enrichment. There is a germ of truth

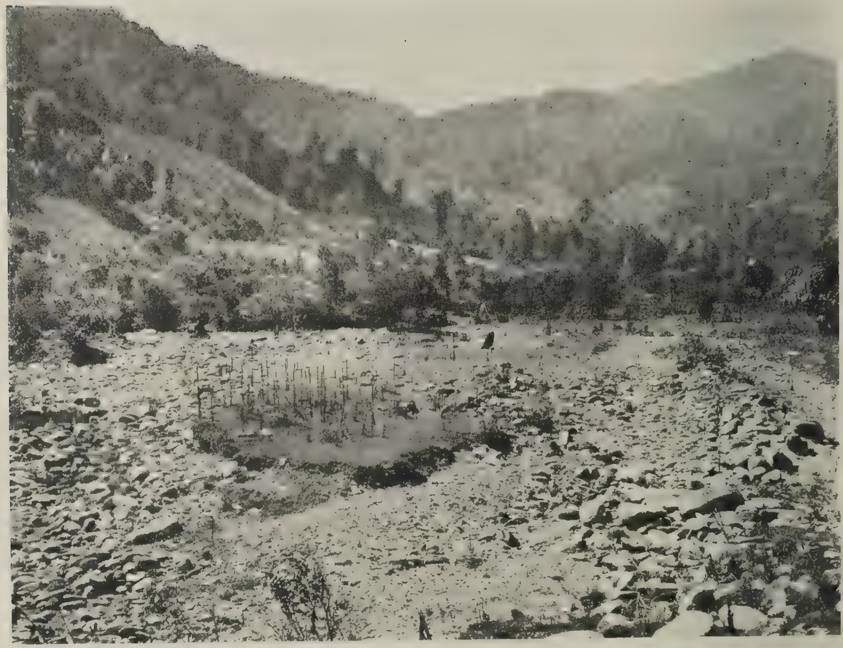

FIG. 19

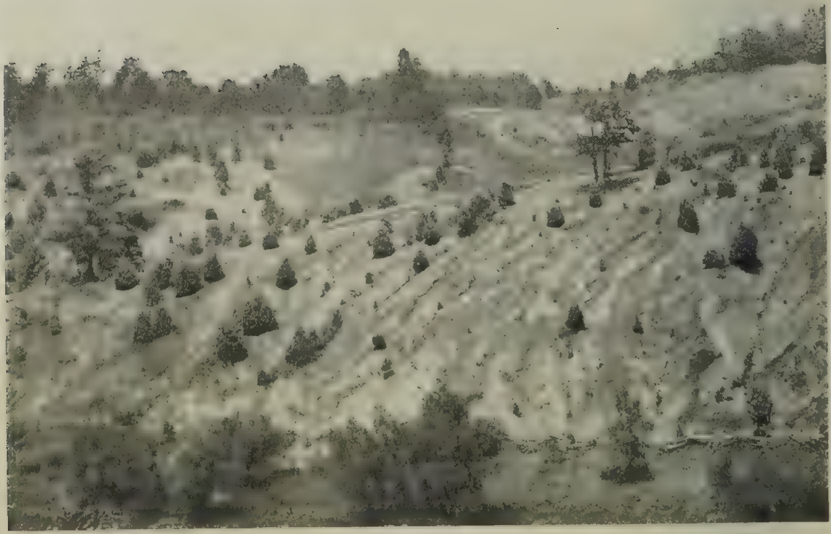

FIG. 20

FIG. 19—The bottom of this stream, Oconalufty River, Swain County, North Carolina, was formerly covered by a rich strip of alluvial land, as represented by the small island area in the center. (Photograph by E. Block, U. S. Forest Service.)

FIG. 20—Deep gullies and abandoned hillside farm land in the Blue Ridge Mountain section. White pine is slowly and difficultly restocking the area. (Photograph by E. Block, U. S. Forest Service.)

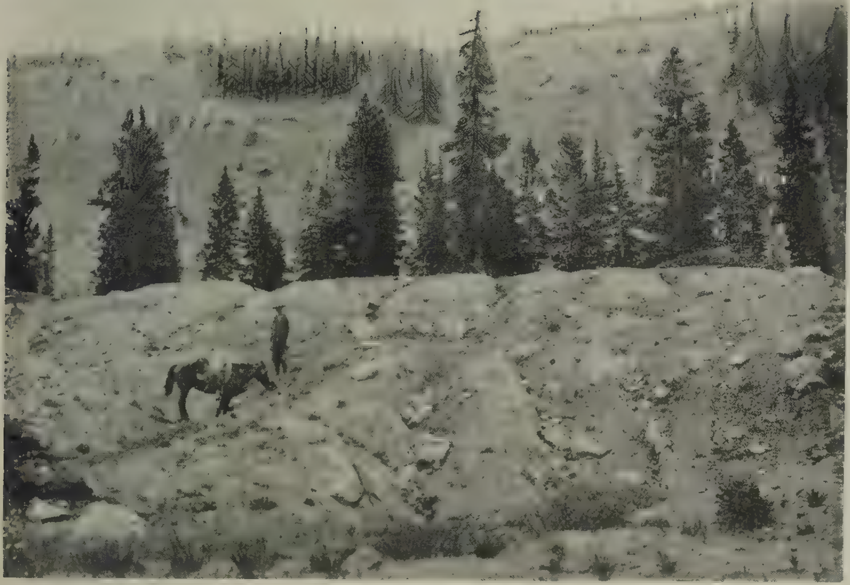

FIG. 21

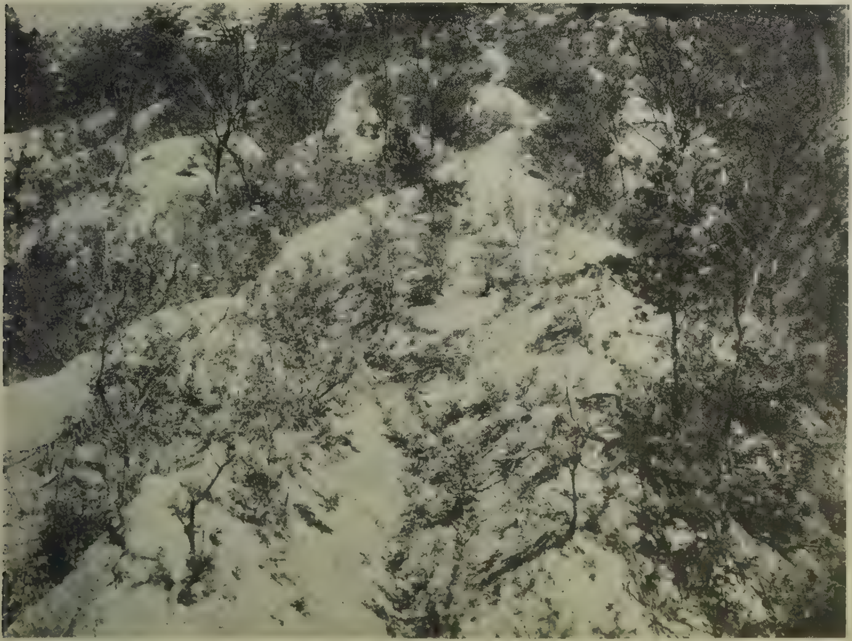

FIG. 22

FIG. 21—Erosional effects following overgrazing of sheep lands, Manti National Forest. (Photograph by U. S. Forest Service.)

FIG. 22—On this gullied slope in southern Ohio (Scioto County), locust trees have been planted to bring the wasted area to some degree of usefulness.

in the idea, particularly with respect to some types of flood plain. In a large measure, however, the conception is fallacious. In the first place, as already pointed out, a large proportion of the eroded material comes to rest temporarily upon lower slopes and flats where it is not needed and often does serious and permanent damage to the land and the crops growing on it.

Furthermore, much of the most productive part of the flood-plain deposits is left upon material of precisely the same origin and character, already having great depth and good productivity. There is, of course, some temporary enrichment of the alluvial soil of some areas by deposition of fine-grained material. Even in the Mississippi flood plain, some increase in the crop yields follow deposition of the finer particles, especially on the more sandy strips along the stream banks. Not much advantage from this source can be expected, however, in case of the highly productive "buckshot" land of this great alluvial plain, the Sharkey clay, which is a deep soil rich in available and potential plant nutrients, often containing three-tenths per cent of phosphoric acid and a good supply of organic matter. Some temporary refreshment is frequently observed, nevertheless, in the older fields, due to the fresh organic matter and nitrates in the deposits. But the increased yields are generally not astounding nor of very long duration.

On the other hand, comparatively infertile material of sand and gravel is frequently deposited over productive alluvial bottoms, causing much damage. Even the floods of the Mississippi lay down patches of almost inert sand, locally known as "sand blows," and injure other areas by deposition of loose sand near the banks and in the vicinity of levee crevasses. The Vermont flood of 1927 laid down over productive meadow lands blankets of coarse sand and gravel that were six feet deep in places. Even boulders weighing a ton were rolled out on some of the alluvial plains. Many thousands of acres of the best land in the state were thus severely damaged or entirely ruined.

In any appraisal of the effects of floods, it is necessary, of course, to weight first the damage done to farm improvements, live stock, and crops. And it is well always to remember that one acre of alluvial material in a stream bottom may stand for many acres of impaired or devastated fields and pastures, upstream, especially when there has been abnormally rapid deposition.

RELATION OF EROSION TO FLOODS

Inadequacy of measurements makes it entirely impossible to estimate the full relationship of soil erosion to floods. There is evidence, however, to indicate that erosion always tends to increase the volume of floods materially. There is abundant proof of this for the smaller streams, and it has not been proved that the same sort of thing does

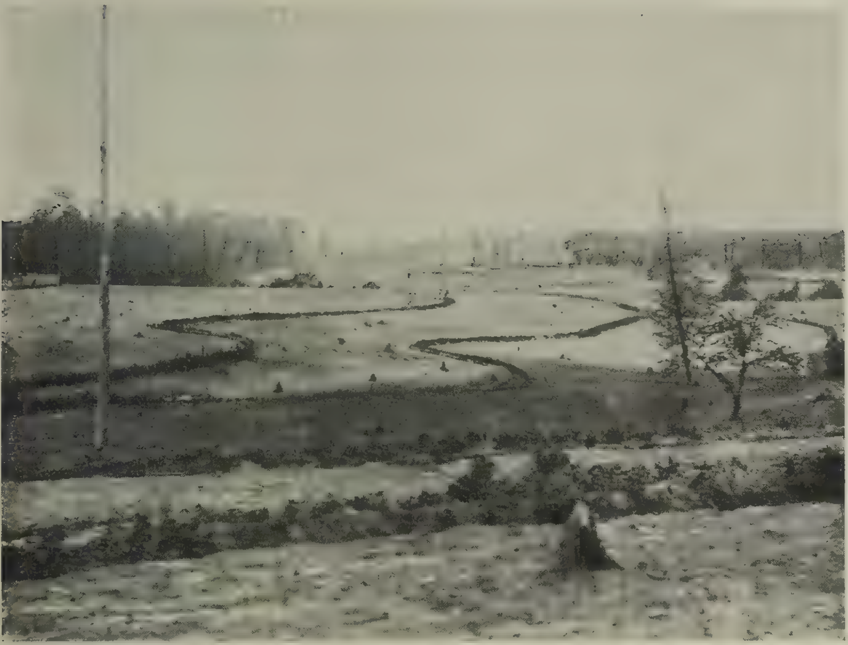

FIG. 23

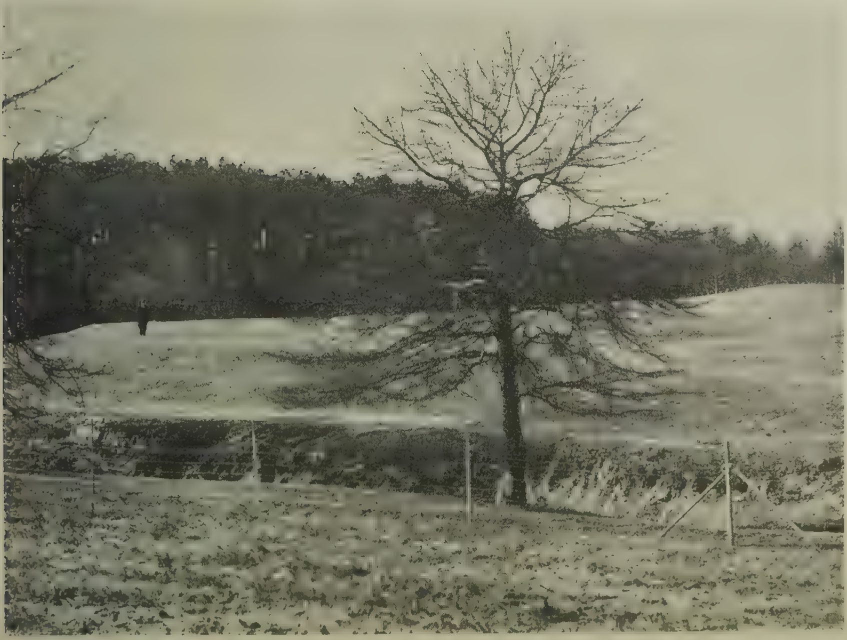

FIG. 24

FIG. 23—A properly terraced field in the Piedmont region. Many fields in this region have been saved by such terraces.

FIG. 24—This Piedmont hillside, formerly a waste of gullies and exposed clay subsoil, has been reclaimed by the use of hillside terraces. The man at left stands on a flat of accumulated material caught by the terrace embankment.

not take place in the larger streams, as the Missouri and Mississippi. We have entirely too little evidence relating to the rains that produced some of the earlier floods so often referred to by those who profess to believe that only conspiring rains and inadequate levee protection have anything to do with such disastrous floods as that along the Mississippi in 1927; and also there are too few precise data relating to these early floods themselves. It would not, however, in the least vitiate the argument of those who see a vital relationship between floods and denuded watersheds if some of the earlier explorers had looked upon floods in the Mississippi that very greatly exceeded the one of 1927, for there was then as now no natural law against overwhelming downpours. There is abundant evidence upon the pages of the world's history that every now and then all the probabilities have been rudely upset. This being true, they may be upset again. The important thing for mankind is not to permit improbable eventualities and unavoidable actualities (the rains) to constitute a negativating deterrent in the setting up of obstacles to those wasteful processes going on under more or less normal conditions.

The largely increased run-off and wash-off from unprotected slopes as compared with protected slopes cannot but add volume to the water of rising streams. Equilibria of current and load, balances of deposition and resuspension, eroding banks, eroding flood plains, etc., enter into the process, of course; but an increased volume of water in a stream is a definite enlargement that cannot be decreased except by part of the water getting away somewhere; and the place most of it must go is the sea, where it arrives as quickly as possible and in as large volume as possible, regardless of the methods of travel involved.

It is perfectly obvious that if a greater portion of water and of suspended and dissolved matter is withheld from the streams the flood hazards which occur at peak stages will be greatly relieved; and, furthermore, both the water and the soil are needed in the fields and pastures where they belong.

Looking Ahead

As a nation we are doing comparatively little to abate the evil effects of this scourge of the land, soil erosion. Those who know from actual experience and observation anything of the process admit it is a serious land problem; but few have seemed to realize how exceedingly devastating it is in its wholesale operation. There is immediate need for a tremendous national awakening to action in bettering our land practices. Terracing and contour cultivation of sloping areas to check erosion has been carried on with excellent results for a long time in parts of the southeastern United States. Recently the method has crossed the Mississippi and is being extensively and increasingly employed in Texas and Oklahoma. But in the region north of the northern line of Oklahoma and Tennessee terraces are rarely employed to protect eroding slopes, or any other means for that matter. Most of the farmers have never seen an efficiently constructed terrace; many of them have never even heard of this embankment method of protecting sloping fields.

The terrace is a very practical implement for saving soil and also for conserving soil moisture in the drier regions. When terraces are properly built, including adjustment to soil and slope, they will pay their way many times over; and whatever they accomplish in holding soil in the fields, keeping it out of the streams, and storing moisture in the subsoil will be a by-product of the operation. In regard to this, however, as to other phases of the problem, investigational work has only begun. We do not yet know what is the best type of terrace for some of the most erosive soils; nor do we know at precisely what slope cultivation should cease on some of the more susceptible lands and the planting of trees or grass should begin. As yet only three types of soil, of the many involved, have had their erosivity measured.

ANCESTRAL OCCUPATIONS OF THE HUNGARIANS

E. D. Beynon

ANY attempt to reconstruct the life of the Hungarians of the *Honfoglalás*, or Home-taking, of 896 A. D. must rest largely upon a study of the primitive occupations which have been preserved into modern times. The past history of the Hungarians before that epochal year is almost purely legendary. The old Hungarian literature, if such existed, was completely destroyed at the time of the Christianizing of the Hungarians in the early part of the eleventh century. Copious annals and chronicles remain, it is true; but they are written in the Latin language and deal almost entirely with the political events of the successive reigns. We search in vain in the pages either of Anonymus or Kézei for information as to how the people themselves lived in that far-off day. The earliest writing that has been preserved in the Hungarian language is the Funeral Oration of the early thirteenth century, which does not greatly enlighten us as to how the people lived!

The generally accepted hypothesis of the origin of the Hungarians is that they are a Turanian people of the Finno-Ugric branch of the Ural-Altaic stock and that their closest living relatives are Ostyaks and Voguls who still roam the slopes of the Ural Mountains and the valleys of the Irtish and Ob in Siberia. Hungarian legend places the ancestral home of the Magyar race in "Jugoria," a sort of fabled paradise lying to the east of the Ural Mountains. Every source of information agrees on this, that the primitive Hungarians were hunters, fishers, and herdsmen and that before the Honfoglalás they lived in precisely the same manner as do the nomadic Ostyaks and Voguls of today, though through a false pride many Hungarians, including the great scholar Arminius Vámbery, have opposed this hypothesis.

It may be assumed that either through the natural increase in population or through the pressure of predatory tribes from the East life in ancient "Jugoria" ceased to be idyllic—became, in fact, so unbearable that the entire Magyar race decided to move westward and find a more suitable home. Some ancient legends give as the motive of the migration overexploitation of the wild life and pastures of the homeland. When the Carpathians had been crossed and the indigenous tribes had been conquered, the land presumably was parceled out among the conquerors. In appropriate places we may still find evidence of the ancestral life. Even to this day the shepherds and herdsmen of the Alföld, the fishermen on the banks of the Tisza and Danube, and the huntsmen in the fastnesses of the Bükk or Bakony Mountains preserve many of the customs held in common with Ostyaks and Voguls. But Hungary is rapidly becoming westernized, and all trace of the way the primitive Magyars lived will soon be obliterated, save for the cultural objects preserved in museums.

Ancestral Hunting

Hunting was the most primitive occupation. The greatest number of occupational words common to Hungarian and its cognate Finno-Ugric languages have to do with this activity. The oldest legends make Menrót—changed by monkish scribes into the Biblical form of Nimrod—the ancestor of the Hungarian people: and this Menrót was like Nimrod a famous hunter. Vastly fewer remains of primitive hunting, however, have been preserved than of primitive fishing or the pastoral life. While these latter remained sources of livelihood for the common people, hunting became reserved exclusively for the king, the nobles, and their servants. The ancestral Hungarians hunted for food, not as a sport. They were interested in catching the game as quickly and with as little danger as possible; hence they used snares, nets, pits, darts, nooses, and the like. The use of all these became strictly prohibited by severe poaching laws. At the time of the Millennial Exhibition of 1896, Nagy Géza, who was appointed to the oversight of this department, lamented his lack of success in securing exhibits of ancestral hunting.

The hunting methods of the Hungarians have passed through certain well-marked stages. Before the migration from ancient "Jugoria," the hunter with his horse and dog would hide in the shadow of some colossal tree to shoot the game with his arrow as it approached and then pursue with horse and dog. The most primitive weapon was the arrow, different types of which were employed for the hunting of different animals. It is probable that the *agár*, or greyhound of Hungary, was one of the animals brought by the invading Hungarians from Asia to their new home. Through the centuries the characteristics of this breed have greatly changed, for the original *agár* was larger, stouter, and had longer hair. In time the Hungarian huntsmen began the use of the lasso, which was thrown from horseback. Still later they employed snares and traps, the use of which has continued to the present time among poachers.

During the seventeenth century the musket began to come into general use for hunting purposes in Hungary; by the beginning of the eighteenth century it had completely superseded the bow and arrow. While the higher nobility used imported firearms, the squires and lower orders of the nobility used home-manufactured muskets until the prohibition of firearms after the War of Independence in 1848–1849.

Certain modes of hunting have never been popular with the Hungarians. The spear, commonly used by ancient German tribes, does not seem to have had great vogue among the Magyar people. The hunting knife was a very late importation into Hungary: until the fifteenth century the sword was used in its stead.

In former days game naturally was far more plentiful in Hungary than now. Owing to the nature of the country, most of the good hunting regions were ceded by the Treaty of Trianon either to Czechoslovakia or to Rumania; yet as long ago as 1896, while Hungary still retained her ancient borders, many lamented the dearth of game. Three valuable species were long since exterminated from Hungary—the beaver, the elk, and the aurochs. The Bükk, Vértes, and Bakony Mountains—which all remain in present Hungary—were anciently vast hunting grounds. A century and a half ago one young noble killed 220 deer in one afternoon.

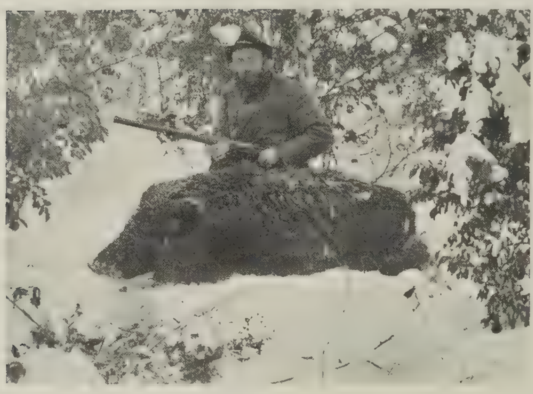

Fig. 1

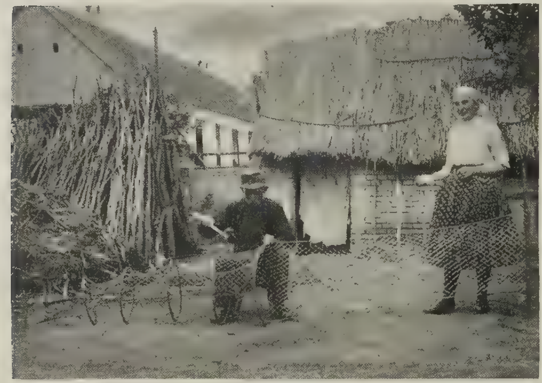

Fig. 2

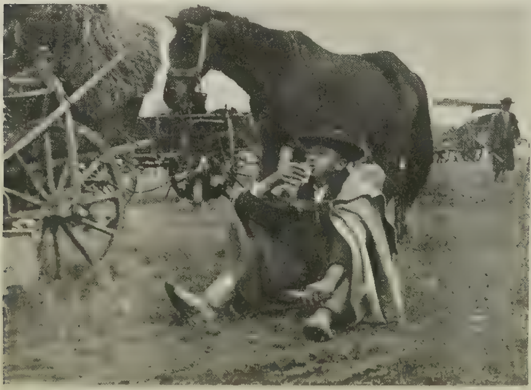

Fig. 3

Fig. 1—Hunting the wild boar. The genuine "hunter type" is here depicted. (This and the following photographs are copyrighted by I. Kerny, Budapest.)

Fig. 2—Making the *varsa*. This net is used for catching eels.

Fig. 3—A *csikós*, or horse boy, drinking a libation—a survival of an old pagan custom.

In spite of the nobles' love of adventure, much of the hunting was not done by them, but by a separate caste, the Royal Hunters. This caste, scattered all over Hungary, was governed by the Lord Lieutenant of the Hunters and was divided into classes according to the different kinds of animals hunted. An interesting survival of this old régime still remains—the Royal Hunters of Szent Gál in the County of Veszprém. Though the Árpád dynasty which settled these people at Szent Gál has been extinct more than six hundred years, they still wear the ancestral hunting costume and observe the old twelfth-century customs.

In the fastnesses of the Bükk Mountains of the County of Borsod I met one day, not far from Szilvásvárad, the forester of the estate of Marquis Pallavicini. He was a typical hunter of the old time, like those of Szent Gál, descended from the Royal Hunters of the days of the Árpáds. These men have a different physique from that of other Hungarians. Might it not be that these Royal Hunters were largely composed of the ancestral hunter tribes?

Although the ancient methods of hunting were abolished long ago, they reasserted themselves during the troublous times connected with the régime of Count Michael Károlyi in the late autumn of 1918. The people of the villages crowded into the estates of the nobles. The destruction of game was terrific. The interesting feature of the matter is the way in which the peasants hunted the game from which they had been kept for so many centuries—in the same manner as their ancestors. Snares and pits were used; if a man could secure a horse, he hunted with its aid and used the pistol; or, failing that, he once more made bows and arrows with which to bring down the deer of the nobles.

Ancestral Fishing

Through the centuries the simple fisher folk of Hungary have changed but little, far less than those who follow other ancestral occupations. From prehistoric times they have preserved practically the same utensils and modes of fishing, practicing on the shores of the Balaton[1] and Fertő lakes and on the Danube, Tisza, Maros, Körős, and smaller rivers the customs they had carried on beside the Ob and later on the Volga.

The conversion of Hungary to Christianity greatly enhanced the importance of the fisherman's occupation. The need of a fish diet through Lent led the cooks of the nobles to devise all manner of fish dishes. In a cookbook of 1680 two hundred and thirteen such recipes are given. To augment the supply from rivers and lakes artificial fishponds were introduced, even before the battle of Mohács, which was fought in 1526. At the present time there is no more flourishing industry in Hungary than that connected with the artificial fishponds. Joint-stock companies with a capital of millions of korona have engaged in some of these projects, as that on the so-called "Bad Lands" of the Hortobágy near Debreczen. There is scarcely a noble who does not have an artificial fishpond on his estate, from which he expects to derive the largest portion of the year's profits. While long ago trout were raised in this way, it was found in time that carp could be raised and fattened more quickly and could find a readier market among a certain class of the population of great cities, both in Hungary and in Poland. Nothing savors less of the romantic past than the efficient business management of the carp-raising industry.

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[1] After the abolition of serfdom in the mid-nineteenth century the landlords insisted on the payment of rent for the ancient privilege of fishing in Lake Balaton: difficulties ensued and the people's fishing rights were completely abolished with the entailment of much hardship.

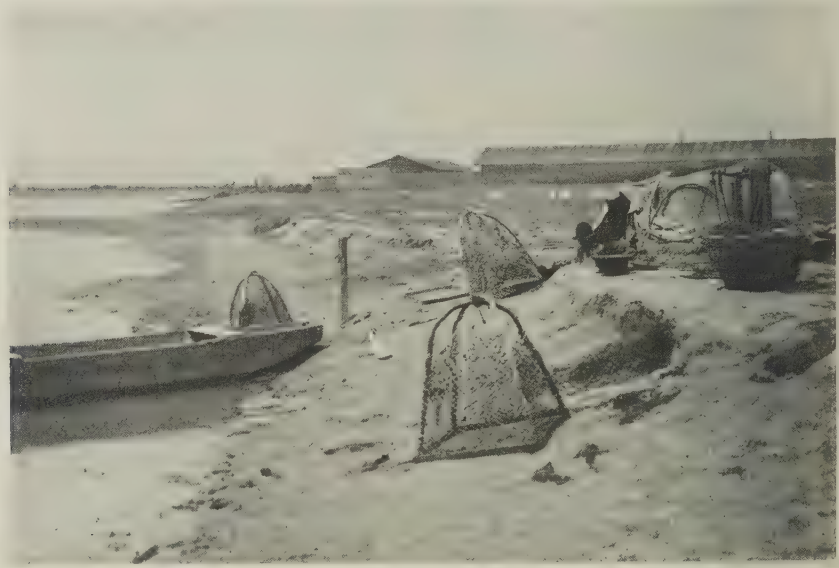

FIG. 4—Fisherman's hovel on the bank of the Tisza, showing the influence of modern commerce. The boat is no longer hollowed out of an oak trunk; canvas now covers the hut instead of woven reeds; the nets have been greatly modernized.

On the other hand the fisher folk along the rivers and lakes use almost the same fishing methods as did their ancestors of a thousand years ago. They do not send the fish they catch to foreign markets; what they have caught the night before they bring to the early morning market in the city nearest them. In all Hungary I saw nothing more picturesque than the stalls of the fishmongers in the market place of Szeged. Even in the selling of fish a very ancient custom is preserved. The fish are fastened to an *ihany*, or wicker frame, so that the buyer may carry them home more comfortably. Hungarian ethnologists point out that a contrivance similar to the *ihany* is sculptured on Egyptian monuments.

Every phase of the life of these fishermen is primitive in the extreme. The hut in which they live has one of two forms—either a tall, conical and pointed structure, the so-called *pákászkunyhó*, made of reeds and resembling the capped hut, *kontyos kunyhó*, of the shepherds, or the form illustrated in Figure 4, which now consists of canvas fastened over a rough framework where formerly it was made entirely of reed and wickerwork. The latter form of hut is quite low and is left permanently open on one side but affords at least a partial protection from the wind and rain. The low hut in its original form was probably that used by the ancestral Hungarians.

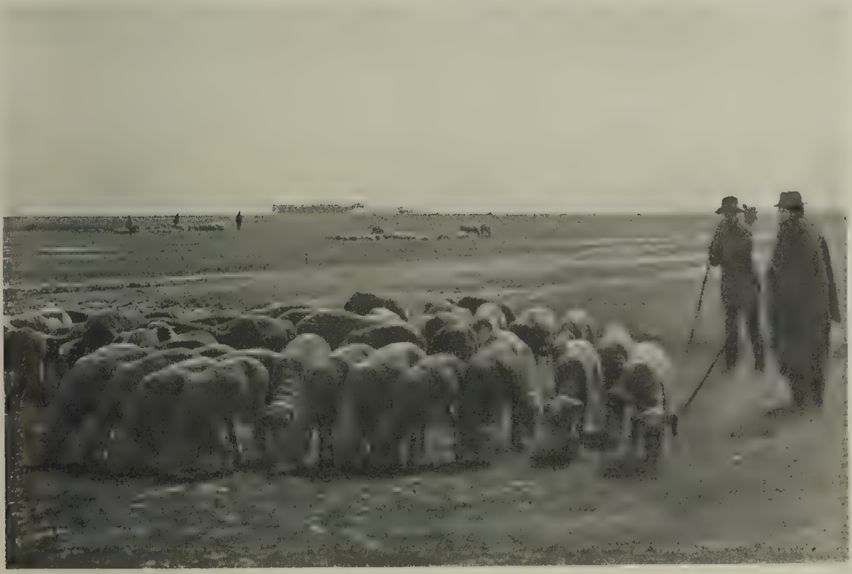

FIG. 5—Shepherds watching their flocks on the plain of Hortobágy.

The fisherman's canoe, *lélekvesztő*, consisted of an oak trunk from which the center had been burned out, a prehistoric type. Unfortunately this interesting survival is no longer used because it recently became impossible for the fishermen to find oak trunks large enough; while commerce has made it possible to buy boards and nails for the construction of a practical if less picturesque craft. The oar used by the fishermen of the Tisza, and especially by those of Szeged, is most interesting. The blade is shaped like a tobacco leaf. Other tribes have copied it but not accurately, their oars rather resembling a willow leaf. It is only on the banks of the Ob that we can find tribes using precisely the same kind of oar as that of Szeged.

The organization of the fishermen was rather significant. Companies, or *halászbokrok*, were formed with collective responsibility and collective privileges of fishing. Usually eight or ten men belonged to each of these companies. The waters—both lakes and rivers—were divided among them. The fragment of a mast or a so-called guard tree, *őrfa*, was set on the shore of the borders of each company's territory. Men of no other company were allowed to fish there. This division of the waters among the companies of fishermen corresponded closely to the division of the boundless waste of the Alföld among the shepherds.

The modes of fishing were numerous. The most primitive contrivance was the *vejsze*, a sort of cane or reed fence with wedge-shaped pickets on the points of which crooked hooks were placed. This was fastened to the mud in the bottom by weights and could not be moved. For sturgeon fishing in the Danube, cables were placed across the river and provided with baited hooks every few feet to catch the fish as they came upstream from the Black Sea. Probably the most skillful fishing with hook and line, and at the same time the most primitive, was that employed by the fishermen in the great marshes known as the Ecsedi Lâp in the County of Szatmâr and the Sârrét in the County of Bihâr; but these marshes have now been drained. An interesting method, which also has gone out of existence, was the *látott halászat*, or sight fishing of the Balaton. A watch would be stationed on the promontory of Tihany on the lookout for a school of *fogas*, the finest fish in Hungarian waters. The signal given, his companions would surround the school with their nets. In the shallower streams the large fish which lay sleeping and basking in the sunlight were harpooned. In winter on the Balaton fish were caught with nets through the ice. The people of two or three villages would all turn out on this occasion, which was regarded as one of the chief holidays of the year.

Different types of large nets were used, but the most distinctively Hungarian form was the *kuszakecze*, a three-cornered dragnet fastened to a wooden frame and dragged after a canoe. Stones around the wooden frame helped to weight the net down; but the net itself was kept in position by nine horse bones—on each side four metacarpal bones and in the center a tibia. The bones were perforated and through the perforation attached to the sinews of the net. The nets shown in the foreground of Figure 4 are modern adaptations. Somewhat similar to the *kuszakecze* is the long, conical *varsa*, used for trapping either fish or eels (Fig. 2).

All of these methods of ancestral fishing are rapidly passing into oblivion. While great care is taken of the artificial fishponds, the natural fishing grounds have been allowed to become almost "fished out." Steam navigation has done much to ruin the fisherman's occupation. The main reason, however, for the decline in ancestral fishing is that which has largely destroyed primitive pastoral life—the drainage of the Alföld and the regulation of its many waters into a few channels.

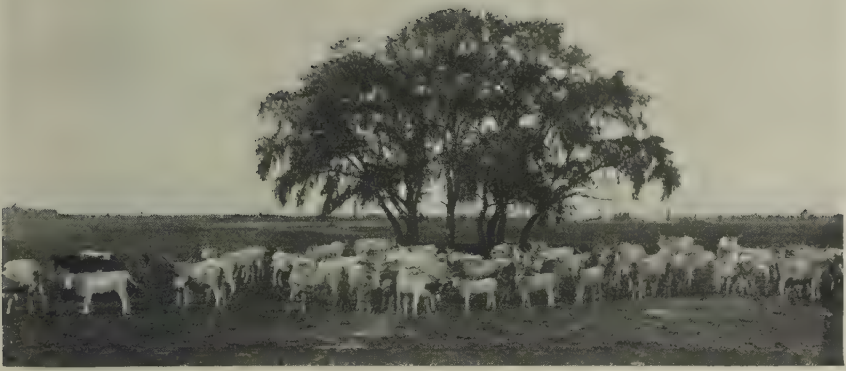

FIG. 6

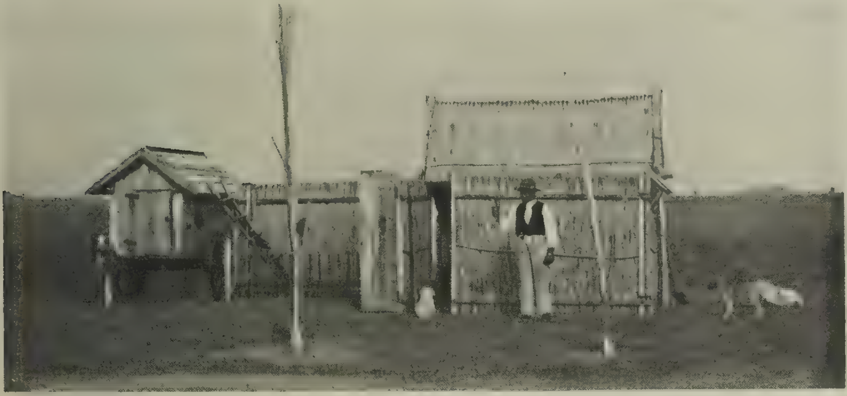

FIG. 7

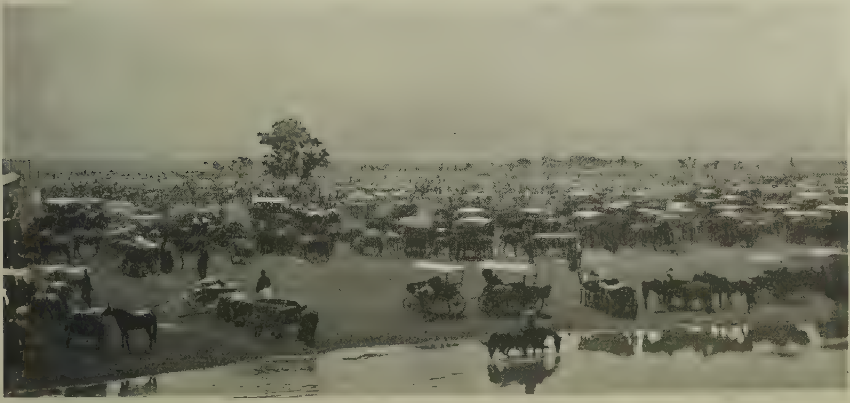

FIG. 8

FIG. 6—A landscape scene in the *Bugacz Puszta*, or steppe, of Kecskemét. Practically the entire herd is of aboriginal Hungarian cattle. This breed, which was brought to Hungary from Asia at the time of the Invasion, is white, long-horned, and exceedingly hardy.

FIG. 7—A *cserény*, or herdsman's house, in the *Bugacz Puszta*. This *cserény* is roofed and so shows a wide deviation from the primitive type.

FIG. 8—The market of the bridge of the Hortobágy, near the famous inn. This market, which was held annually on June 17, was attended by merchants from as far as Budapest and Vienna.

PASTORAL LIFE

More than any other ancestral occupation the pastoral life was a direct continuation on the plains of Hungary of the old life led on the steppes of Asia. The nomadic Hungarians of the Period of the Invasion brought their flocks and herds with them from the old home of their race. It is practically impossible any longer to find the native Hungarian breed either of horses or of pigs; but to this day many of the herds of cattle, many of the flocks of sheep, many of the watchdogs are direct descendants of animals brought into the country in 896.

The Hungarians settled in their new home by tribes and clans rather than as individuals. Their animals were collective property, and hence the land pastured by them was left unfenced. At first only a small portion of the unfenced pasturage was set aside for tillage and the raising of grain, the so-called *ökörtilalmas*. Many survivals of this old state of affairs are yet to be found. Even now the villagers have communal rights to their forest and pasture lands, though they own the animals individually. There are, however, great cities like Debreczen which have corporate ownership of flocks and herds. Debreczen, as a city and apart from the property of its individual owners, owns 41,000 animals, of which 11,000 cattle, 4900 horses, 2300 sheep, and 2100 pigs are thoroughbred. These are pastured on the Great Plain of the Hortobágy, also the property of the city. Apart from the area needed for the city's herds and flocks there are extensive tracts rented to individual citizens for pasturing their animals.

As the majority of the people exchanged the pastoral for the agricultural life a definite class developed, the *pásztorok*, a term much wider than our "shepherd" as it includes those who tended horses, cattle, and pigs as well as sheep. Bátky Zsigmond, in describing this class, goes so far as to say that "they formed a state within the state." This at any rate is true: they remained apart from the villages both winter and summer. A halo of romance has encircled their life; but to us the most interesting thing about them is that they live today in almost the same way as Árpád's people lived in 896.

The principal division of these *pásztorok* was fourfold. Those who tended horses were called *csikósok*, a name which literally means "coltherds." Their class was the flower of the life of the plains; they were the heroes of the folksongs; they were and still are the attraction of the girls of the villages that surround the plain. The tenders of cattle were the *gulyások*, or herdsmen, a class but slightly inferior. Those who tended sheep were the *juhászok*, and the swineherds were known as *kondások*. The life of these men out on the plains was patriarchal in the extreme. Especially in the case of the *gulyások* and *csikósok* the little group formed a sort of organized state. At the head was the *főszámadó*, or head herdsman, literally chief accountant. Under him was the *számadó bojtár*, chief of the young herdsmen, who stood midway between the ruling *főszámadó* and the common herdsmen, many of whom entered this life at as early an age as ten years. Finally there was the *lakos*, or housekeeper, usually some older, reliable man.

The *cserény*, or dwelling place of the herdsmen, probably retains almost the same form as that used by the ancestral Hungarians. It is merely a four-cornered enclosure, open on top and on one side. The walls on the other sides are made of reeds and canes woven together. Such a structure could be easily pulled down and quite as easily put up again. It suited a perfectly nomadic people: and these little communities of herdsmen were, and to some extent still are, nomadic. Because of accumulation of manure and other litter it has been the custom to take down the *cserény* and move elsewhere at least every eight days.

A bit of thatch put over one corner—that farthest removed from the open side—formed the so-called tent which protected the property of the herdsmen, their chests, saddles, wallets of bacon, and the like. Inside the enclosure, but beside one wall, was the *szolgafa*, a trestle from which was hung the iron kettle with its finely carved wooden spoon. This was the kitchen. Outside the enclosure was the *gunyapad*, on which rough bench the *számadó* often slept. In front of the *cserény* were poles to which cows were tethered at milking time. No picture of this primitive habitation would be complete without the *talyiga* or two-wheeled provision cart (Fig. 7).

The evolution of the *cserény* is very interesting. Its most primitive form gave place in time to the roofless but horseshoe-shaped *vasaló* of the Hortobágy and to the cone-peaked *kontyos kunyhó* of the Ecseg Puszta of Turkeve. In time thatched roofs came into use, and the thatched sides gave place to boards, the habitation becoming a rather squalid hut.

Each class of the *pásztorok* has its distinctive dress. The most striking, naturally, is that worn by the *csikósok*. His love of ornamentation extends not only to his own clothes but also to the trappings of his horse and all the articles large and small with which he is surrounded. While the artistic instinct seems more marked in the *csikós* and the *juhász* than in the other two classes, it is to a large extent common to all who follow pastoral life. The life itself, partly slothful, partly adventurous, seemed to stimulate greatly the desire to make things beautiful. When one sees the delicate and beautiful figures carved by these men in their spare time on the handles of their wooden spoons and ladles, on their saltcellars, on their whip handles, canes, and other articles, one is amazed at the artistic ability displayed. As this art will soon be a thing of the past, collections of these things should be made before they are all lost or destroyed.

RUSSIA: TERRITORY AND POPULATION

A PERSPECTIVE ON THE 1926 CENSUS

Benjamin Semenov-Tian-Shansky

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AFTER the discovery of America by Columbus a vast colonization movement sprang up among the nations of Europe in two directions, westward towards America and eastward to Asia. The late Russian geographer, P. P. Semenov-Tian-Shansky, has calculated that of all emigrants beyond the Atlantic and the Asiatic frontier from the end of the fifteenth century to the end of the nineteenth 72 per cent, consisting principally of Western Europeans, went to America, and 28 per cent, chiefly Slavs, emigrated eastward to the interior of Eurasia (Alexander von Humboldt's term), if the ethnographic boundaries within the territory of the Russian plain between the European and Asiatic nations of those days be taken into account—for Russia has never recognized the artificial division of the northern continent of the Old World into Europe and Asia.

The importance of the great Slavonic colonization eastward into the interior of Eurasia has not been duly appreciated in Western Europe and America. And yet if there had not been this movement, Western Europe would have been obliged to spend so much energy in fighting the Asiatic hordes of invaders from the East that sufficient strength would not have been left to colonize America. It was only under cover of the Slavs on the east that Western Europe was able to retain the classical purity of its civilization. This is confirmed by the famous invasion of the Huns in the fifth century, which caused a panic throughout all Western Europe, as also by later ones, the strength and impetus of which are so vividly described by the traveler G. E. Grum Grzhimailo (in a new work of capital importance, "Western Mongolia and Uriankhai") that even now, several centuries after these nomads' invasions have ceased, we shudder in reading of them. The repeated attempts of Western Europe to vanquish the specter of "Russian Imperialism," so-called (1604–1617, 1700–1721, 1812, 1854–1855, 1904–1905, 1918–1920), were ill-advised and invariably amounted to little, even when Russia was defeated, for they were attempts against the natural geographical conditions of the country, rather than its population. Napoleon's campaign to Moscow in 1812 is illustrative. The situation was well expressed by an Austrian prisoner sent to eastern Siberia in 1916. Appalled by the great distance he said: "You

Russians cannot be conquered, because, in case of defeat, you can always escape so far that it would be impossible to overtake you."

The Vast Extent of Russia

Whilst the movement towards the east was proceeding, accompanied by an armed struggle of the settlers with the Asiatic nomads, the Russian Empire was formed. In continuous extent of state territory from west to east, this Empire holds the record in the whole history of humanity. While Alaska was still a Russian possession the Empire measured 11,000 kilometers from Kalisz to Mt. Adams. Even now, when it has decreased to 9000 kilometers (Proskurov to Bering Strait), it exceeds the other great territorial units that the world has known—the medieval states of Mongolia and Arabia, 7000–8000 kilometers; ancient China, Persia, Macedonia, and Rome, as also the modern United States of America and Canada, 5000–6000 kilometers. Moreover, the great empires of antiquity in the Old World and the medieval Arabian caliphate were situated between the annual isotherms of 10° C. and 30° C., and the Mongolian Khanate between 0° C. and 30° C., while Russia extends between the isotherms of 20° of heat and 20° of frost—a range such as occurs in the continuous territory of no other state in the world. In Canada this range attains 30°, in the United States without Alaska 20° and even with Alaska not more than 38°, in China less than 30°. This enormous range is illustrated by the accompanying map of the thermal zones of Russia, showing the annual duration of frost (Fig. 1).

The Great Extremes of Climate

From this map it may be seen that about half of the territory of the present Soviet Union has frost during more than half the year, while in the remaining part of the country approximately as far as the northern limit of hot summers (above 20° on the average) a long period of the year, about one-third, consists of transitional seasons—a spring, with its protracted period of bad roads and river floods caused by the melting of snow, and a rainy autumn, also with its long period of bad roads. Moreover, throughout the greater part of the Soviet territory, as a result of its being geographically unprotected from north winds, a temporary and sharp return of cold weather not infrequently occurs. A considerable part of the territory of northern Russia is characterized by a permanently frozen subsoil, the area so occupied being more extensive than similar tracts in North America, if Greenland and the North American archipelago be excluded as being separate islands. This condition is a considerable drawback to agriculture and to construction that penetrates to any depth. Only some inconsiderable districts of the coasts on the Murman and on the

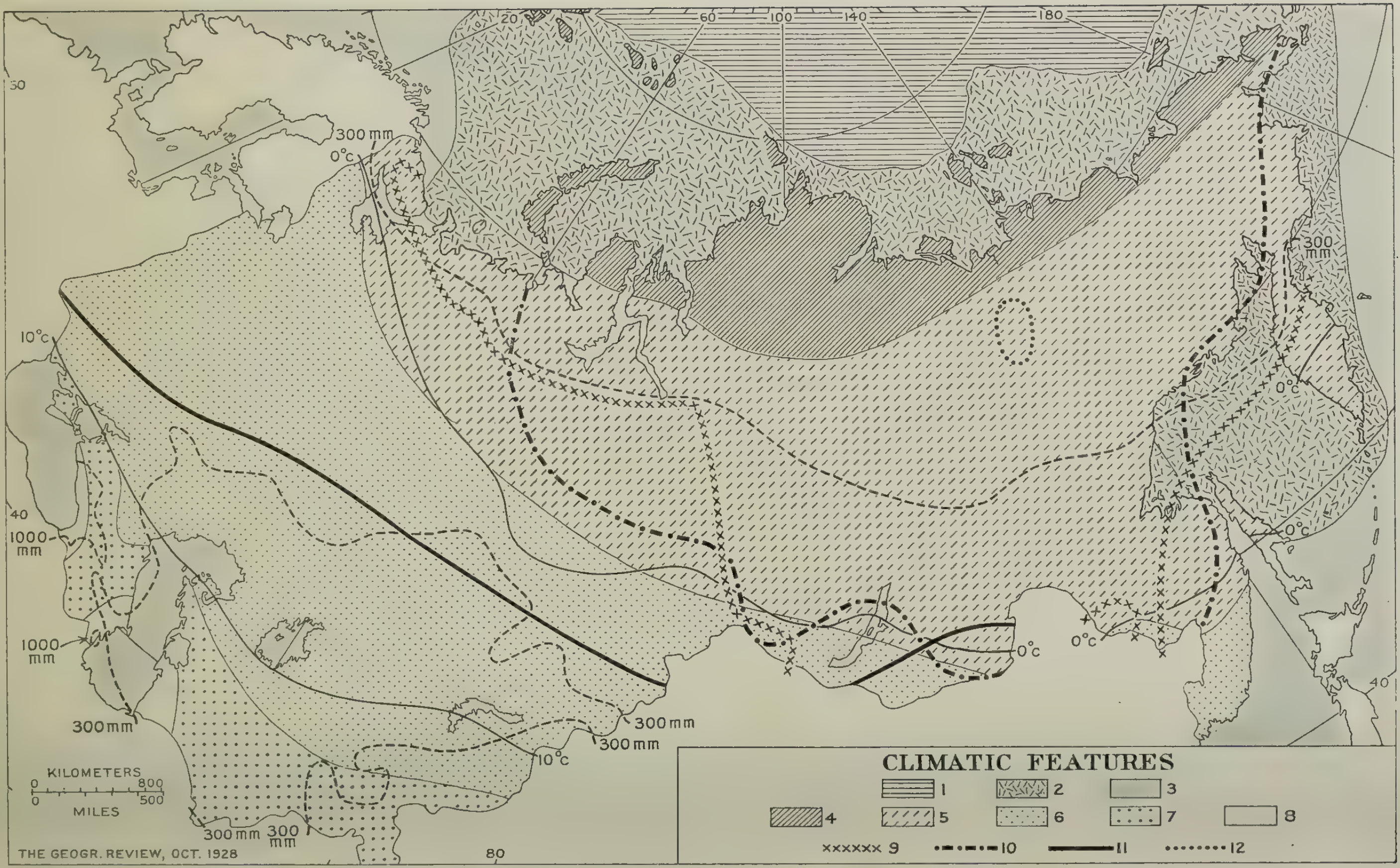

FIG. 1—Climatic features of Russia, compiled by B. and I. Semenov-Tian-Shansky. 1, sea almost completely ice-covered; 2, sea with floating ice; 3, sea ice-free in summer; 4-8, duration of frost—4, 9 months; 5, 6–9 months; 6, 3–6 months; 7, 1–3 months; 8, less than 1 month; 9, limit of permanently frozen ground; 10, limit of cold winters (more than 20° C. of frost); 11, limit of hot summers (more than 20° C. of heat); 12, January "Pole of Cold" (– 45° C.). Mean annual isotherms 0° and 10° C. are shown and isohyets of 300 millimeters and 1000 millimeters.

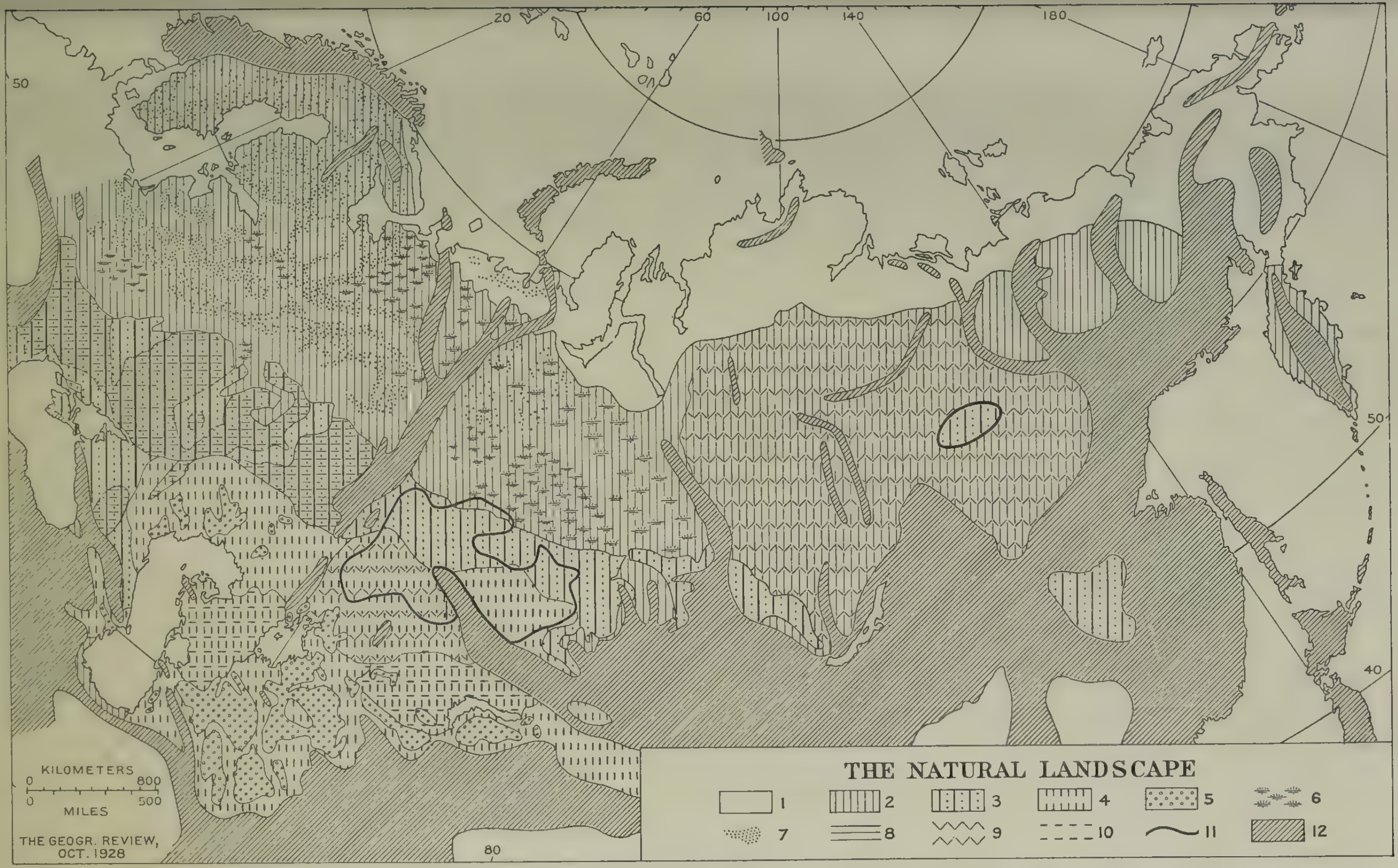

FIG. 2. The natural landscape of northern Eurasia, compiled by B. Semenov-Tian-Shansky. 1, tundra; 2, semiforest and forested plains; 3, semisteppe and steppe plains with black soil; 4, dry steppe and semidesert; 5, sand desert; 6, marshes; 7, hilly morainal landscape; 8, dissected plateau; 9, plateau with tabular uplands; 10, waterless plateau; 11, limit of lake-studded plains of interior drainage; 12, mountain landscape.

Black and Caspian seas have access to waters that never freeze. Even Canada is favorably distinguished from Russia by possessing a longer coast line on the never freezing Pacific Ocean, not to mention the Atlantic, while having no extensive inland territory with a hot summer season. The Pole of Winter Cold (more than −40°) is situated in northern Greenland, not in the interior of Canada, whilst within the Soviet Union it lies in the interior near Verkhoyansk.[1] Within the boundaries of the Soviet Union frostless areas occupy but quite insignificant tracts on the coasts of the Black and Caspian seas.

On the other hand the territory of the Union with a hot summer has a low rainfall, less than 300 mm., and belongs to the region of semideserts and deserts (see Figs. 1 and 2). It is thus not astonishing that these severe natural conditions have reacted unfavorably upon the history of the country and that a low level of culture and slow progress have characterized the Slavonic colonizing movement towards the east. The country is, however, distinguished by the extraordinary adaptability of the race as recognized long ago by Elisée Reclus. During their eastward migrations the Slav settlers have shown a disposition to miscegenation with the primitive aborigines of the forest and of the polar regions, earlier acclimatized, as also with the nomads of the southern deserts. In this respect Slav colonization exhibits common features with that of the Spaniards of America who mixed with the natives. But the miscegenation of the Spaniards with the chief Indian peoples—those of the Aztec and Incan Empires for instance—was culturally more favorable, as the latter were already in possession of their own original fairly high civilization, while the cultural level of the tribes of Eurasia with whom the Slav mixed was for the most part very low.

And yet, even under these various adverse circumstances, nowhere but in Russia, as pointed out by Woeikov, is there such a dense population in such high latitudes. The yearly isotherm of 4° C. passes through Peter the Great's city, which had before the World War more than 2,000,000 inhabitants.

Centers of Territory and Population

Great Russia had its birth in the center of the plain of eastern Europe in the triangle between the Volga and the Oka, where was the cradle of the Muscovite dominion. From here it spread on all sides, though unequally, reaching the Arctic, Baltic, Black, and Caspian seas and the Pacific Ocean. This growth of the state territory was at times accompanied by losses on the borders, partly voluntary, partly enforced. Hence, the geographical centers of territory and population have always been subject to change. The positions of these centers according to the general census of 1897 were calculated by the distinguished chemist Mendeleev in 1906 not long before his death. Later some corrections in his calculations were made by the physicist Weinberg, who also calculated the historical transpositions of the centers of the territory of the country and those of its population from the foundation of the Muscovite dominion until 1914.

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[1] Sergei Obruchev on his recent journey in northeastern Siberia ("Discovery of a Great Range in Northeastern Siberia," *Geogr. Journ.*, Vol. 70, 1927, pp. 464–470) experienced extreme cold on the Upper Indigirka and suggests a possible extension of the "Pole of Cold" over that area.—Edit. Note.

The second general census of population took place in 1926. In connection with this census a special "Centrographical" Laboratory, named after Mendeleev and attached to the statistical section of the Russian Geographical Society, was founded under my direction. The mathematicians Sviatlovsky and Bobrik are there occupied in the determination, by weighing and numerical calculation, of the modern centers of territory, population, and various economic phenomena both for the whole Soviet Union and for the separate republics composing it.

As may be seen from Figure 3, the eastward movement of the center of territory was especially rapid in the seventeenth and at the beginning of the eighteenth century when the Russian Cossacks had reached Alaska, having rapidly succeeded in covering without check a space of thousands of kilometers in uninhabited high latitudes. In the eighteenth century the geographical center of the country lay almost on the watershed of the basins of the Yenisei and the Lena. Later, as lands in the west and south were annexed and Alaska was sold to the United States in 1867, that center began to recede in a southwestern direction and in 1914 reached Tomsk. The most extensive loss of border territory occurred in 1918 on the northwestern, western, and southwestern frontiers of the state, when Finland, Estonia, Latvia, Lithuania, Poland, Bessarabia, and a part of Armenia and Adjaristan were lost. But, as in 1918 only a strip of land, narrow as compared with the entire extent of the country, was lost, the center has not moved far, being now situated east of the river Tom between the Ob and the Yenisei.

The historical movement of the center of population was towards the southeast from Moscow, the movement being considerably slower than that of the center of territory. Thus from the beginning of the fourteenth until the beginning of the twentieth century, i. e. during 500 years, the center of population had moved from Moscow altogether a distance of little over 400 kilometers, as far as the government of Tambov, including a deviation to the west in connection with the annexation of the territories of the former Polish-Lithuanian state. The southward movement of the center of population was due to migration to the fertile black earth steppes. Here the nomadic population presented a serious obstacle. During the armed fight with the nomads in the sixteenth and seventeenth centuries, the Russian settlers built wooden turreted walls and earth ramparts and put up

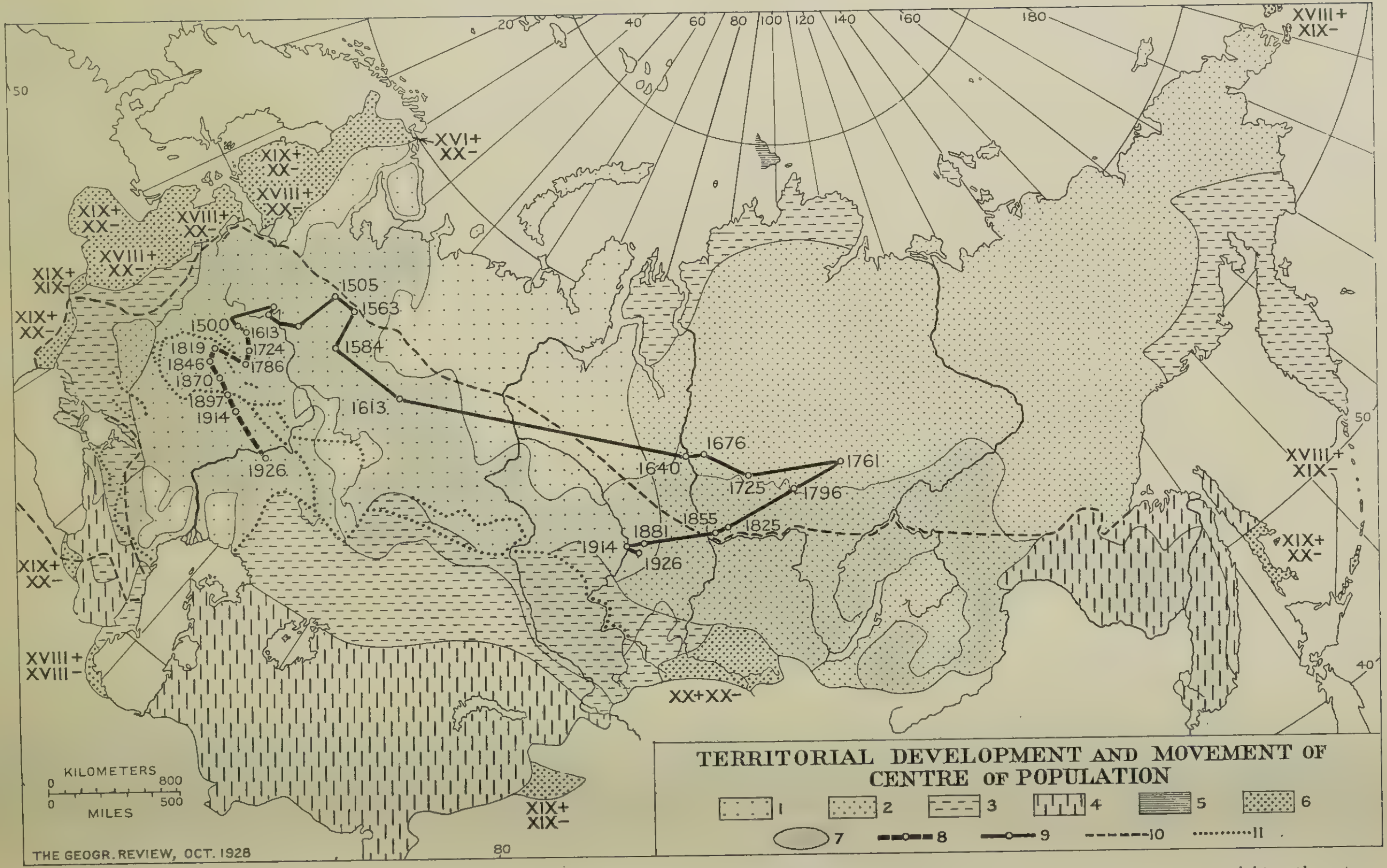

FIG. 3—Historical development, compiled by B. Semenov-Tian-Shansky. Territory acquired by Russia in: 1, sixteenth century; 2, seventeenth century; 3, eighteenth century; 4, nineteenth century; 5, twentieth century; 6, lost territories; 7, over 50 per cent Slavs in the population (twentieth century); 8, movement of center of territory from 1500 to 1926; 9, movement of center of population; 10, northern and western boundaries of the Mongolian-Tatar dominion of about 1300; 11, defensive lines against nomads and

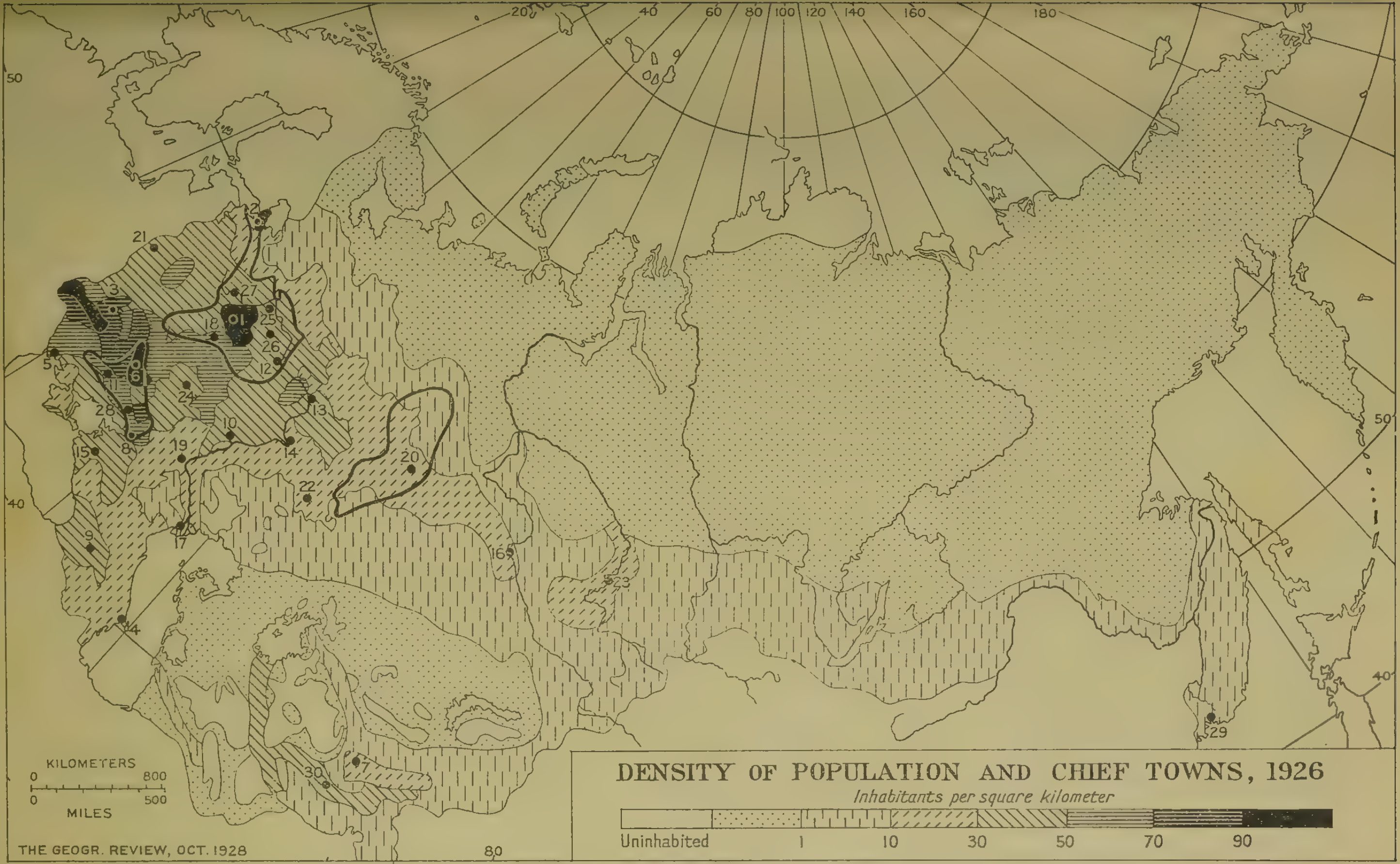

FIG. 4—Density of population and chief towns according to the census of 1926, compiled by B. Semenov-Tian-Shansky. Towns with over 100,000 are shown; the numbers correspond with the list of towns given in the text, Table I, on p. 635. The heavy lines enclose the three regions having the greatest development of urban settlement.

barricades in the forests. These fortifications, known as "watch lines," extended for more than three thousand kilometers from the Desna, a tributary of the Dnieper, to the Altai, with an interval in the Ural Mountains, i. e. throughout a distance nearly equal to the famous Great Wall of China. A sample of such a wooden fortification in the shape of walls with towers (*ostrog*, "keep") still existed in the far-away north at Yakutsk till the last revolution, when with the exception of one tower it was pulled down to be used for fuel.

The watch lines by their very existence caused a concentration of the population behind them. And as at that time Siberia was being colonized in an eastern direction under the cover of similar fortifications, the resultant of the center of the population was a short line directed to the southeast of Moscow. The Polish territory lost in 1918 in particular was thickly populated, hence in 1926 the center of population of the Soviet Union has been moved comparatively rapidly and very markedly in an east-southeastern direction, and now lies in the German republic on the Volga. Thus, owing to historical and geographical causes, the center of the territory of Russia as seen on the map is more than three thousand kilometers distant from the center of population, whilst in the United States of America the distance between the two centers is only about a hundred kilometers. Russia must needs increase the colonization of Siberia to lessen the discrepancy.

The Peoples of the Soviet Union

The territory of the Soviet Union, as has been shown by the latest investigation of the Academy of Sciences, is inhabited by 169 ethnic groups belonging to ten major divisions: Indo-Europeans (36); Japhetic or Caucasian tribes (40); Semites (6); Finns (16); Samoyeds (1); Turks (48); Mongols (3); Tungus-Manchurian tribes (6) Paleoasiatics (9); and groups of tribes (4) from the Far East with an ancient culture (Fig. 5). So many different peoples throughout a continuous territory with no oversea colonies is hardly to be found in any other state of the world. Since the white race forms about three-fourths of the whole population of the Union, the yellow race only one-fourth, the country should be assigned to the Western civilized world of Eurasia, though not without a distinctly eastern cast. On Figure 6 are shown the boundaries of the republics and autonomous provinces constituting the Soviet Union. From this map and Figure 5 it may be seen that the republics are territorially so distributed that in each of them as far as possible there predominates one of the most numerous nationalities of the Union, while at the same time into each there enters a Slavonic element in greater or lesser degree. This occasionally gives rise to a markedly sinuous character in their boundary lines and even to a discontinuity of territory, parts of a state being separated from the main body, as is the case in the Bashkir, the Buriat, and the Caucasian republics: but such is the inexorable working of the national principle laid down as the foundation of the territorial distribution.

Increase of Population

According to the second general census of December, 1926, Russia had 146,000,000 inhabitants. Thus, notwithstanding the losses caused by the World War, the civil wars, and the Revolution and despite the loss of territory with 27 millions of population now entering into the composition of seven independent states (Finland, Estonia, Latvia, Lithuania, Poland, Rumania, and Turkey) and also the loss from death by epidemics and famine, the population of the Soviet Union still exceeds by 17 millions that of the Russian Empire as it was almost thirty years ago, when according to the first general census of February, 1897, the population numbered 129,200,000.

This increase in the population is very unevenly distributed: it amounts to 164 per cent in the Far East, 140 per cent in Siberia, and 58 per cent in the northern Caucasus. It is true that these are districts of interior colonization; still the natural growth of the local population has also been great. In former times natural increase was checked by the great mortality of children under one year of age. In recent years this has been visibly lessened, and progress in this respect will be more rapid in the future. The growth of the population in the central parts of the Russian plain (24 per cent) was not high, nor was it in the Usbek and Turkoman republics (28 per cent), nor in Daghestan (8 per cent). The famine of 1921 caused a decline of population between the years 1920 and 1926 in the areas affected: in the government of Samara, as much as 18 per cent; in the German republic of the Volga, 17 per cent; in the Troitsk district of the Ural province and the government of Orenburg, 16 per cent; in the Tatar republic, 14 per cent; in the Bashkir republic, 12 per cent.

Among the federal republics forming the Soviet Union the first place in number of inhabitants goes to the Russian republic with 100.5 millions; then follow the Ukraine with 28.9; Transcaucasusia, 5.8; Usbekistan, 5.1; White Russia (abnormally diminished by territorial loss), 4.9; Turkmenistan, 1.

Geographical Distribution of the Sex Ratio

The geographical distribution of population according to sex is an important question to which too little attention is paid. In 1897 the population of the Russian Empire was equally divided as regards sex. In the northern half of the western part of the country women predominated, irrespective of race, and vice versa in the southern half.

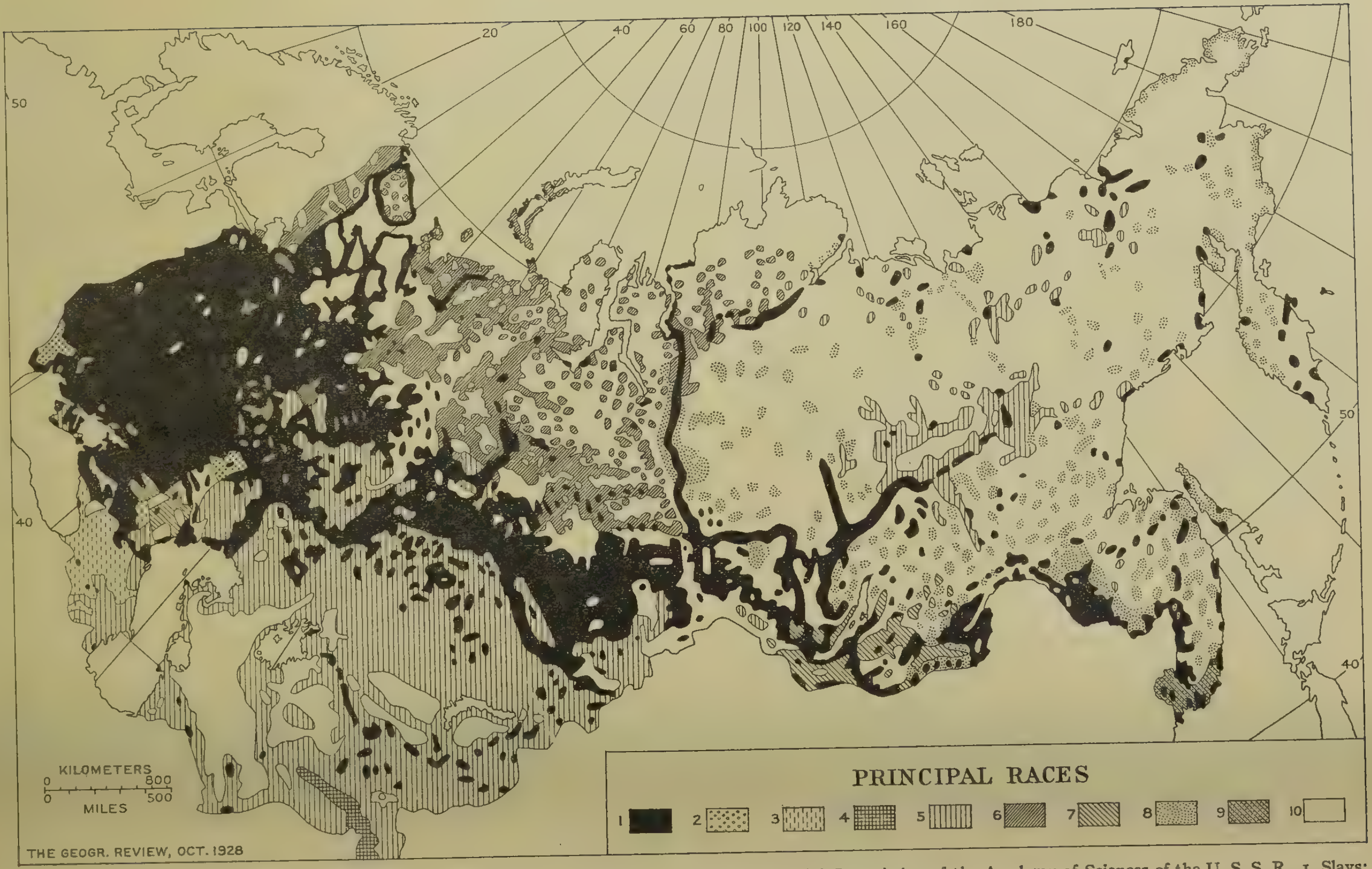

FIG. 5—Principal races of Russia, compiled by B. Semenov-Tian-Shansky from maps of the Special Commission of the Academy of Sciences of the U. S. S. R. 1, Slavs; 2, Rumanians, Germans, and Greeks; 3, Japhetic peoples and Ossets; 4, Iranians; 5, Turkic peoples; 6, Finnic peoples and Samoyeds; 7, Mongolic peoples; 8, Tungus and Paleo-

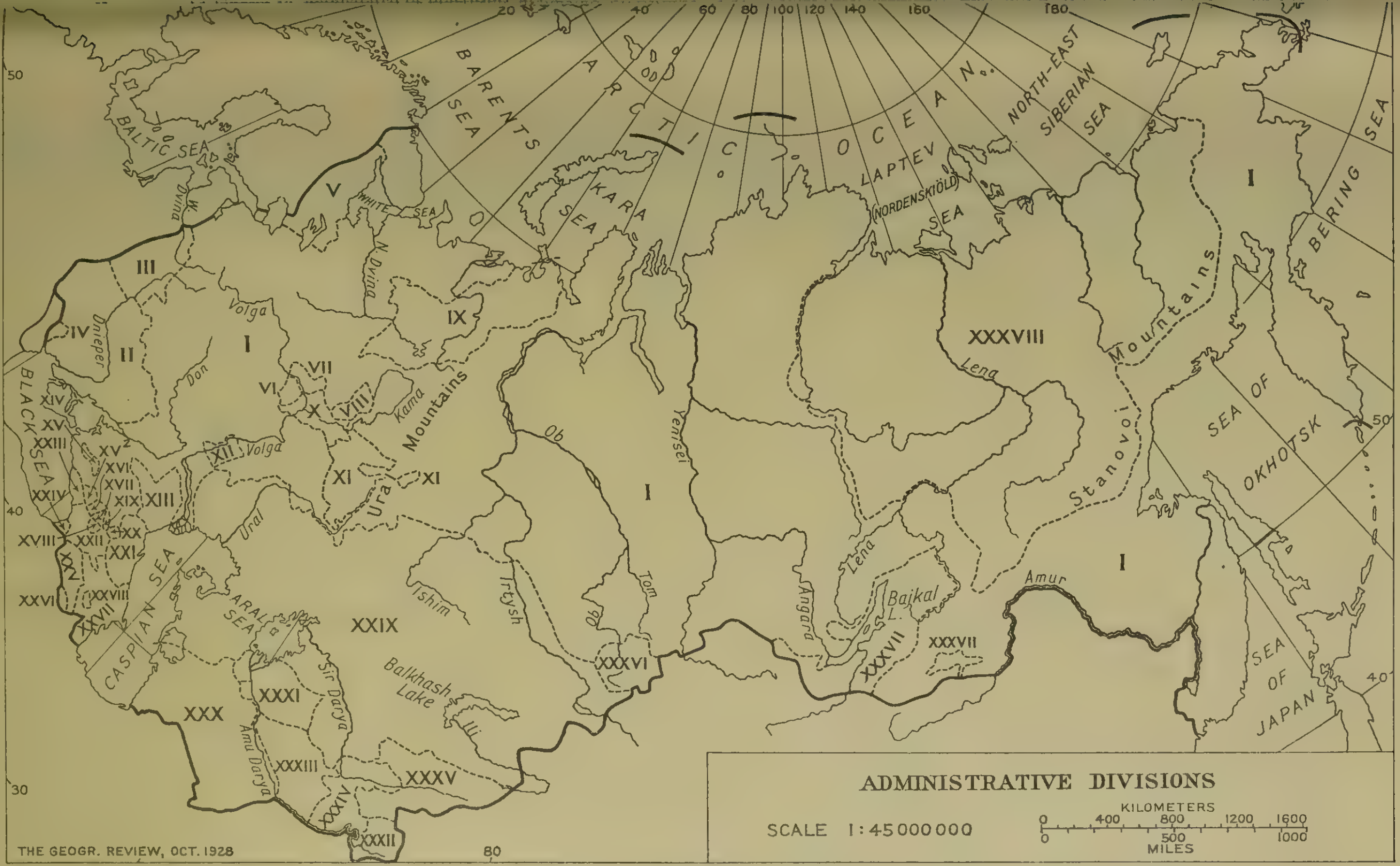

FIG. 6—The republics and autonomous provinces of the Soviet Union. I, Russian Republic; II, Republic of the Ukraine; III, White Russian Republic; IV, Moldavian R.; V, Karelian R.; VI, Chuvash R.; VII, Mari Autonomous Province (Cheremisses); VIII, Votsk A. P.; IX, Komi (Zyrian) A. P.; X, Tatar Republic; XI, Bashkir R.; XII, Republic of the Germans of the Volga; XIII, Kalmuck A. P.; XIV, Crimea A. P.; XV, Cherkess-Adigei A. P.; XV², Karachai A. P.; XVI, Kabardino-Balkar A. P.; XVII, North Ossetian A. P.; XVIII, South Ossetian A. P.; XIX, Ingush A. P.; XX, Chechna A. P.; XXI, Daghestan; XXII, Georgian R.; XXIII, Abhazian R.; XXIV, Adjar R.; XXV, Armenian R.; XXVI, Nakhichevan R.; XXVII, Azerbaijan R.; XXVIII, Karabakh A. P.; XXIX, Kazakstan (Kirghiz) R.; XXX, Turcoman R.; XXXI, Kara-Kalpak A. P.; XXXII, Badakhshan A. P.; XXXIII, Usbek R.; XXXIV, Tadjik R.; XXXV, Kara-Kirghiz R.; XXXVI, Oirat A. P.; XXXVII, Mongolo-Buriat R.; XXXVIII, Yakut R.

Climate is apparently responsible. It is well known that female infants endure the inclemencies of the season better than male infants who, in particular, are susceptible to the catarrhal diseases that are more prevalent in a cold and damp climate. The territorial limit of the numerical predominance of women in European Russia in 1897 may be said to correspond roughly with the annual isotherm of 7° C. According to the 1926 census it has moved southward to about 14° C. This is largely to be attributed to the series of calamities that overwhelmed the country from 1914 to 1921 and which affected chiefly the male population. The Transcaucasus alone has retained an insignificant excess of men, the ratio being 50.8 per cent against 54 per cent in 1897.

In all Asiatic Russia except the government of Tobolsk, which was first colonized (last quarter of the sixteenth century), there was a considerable predominance of men in 1897, as is characteristic of pioneer regions. On the shores of the Pacific the ratio of men to women was 68.4 to 31.6; and on the island of Sakhalin, then a convict colony, 72.9 to 27.1. Now the tables are turned, and throughout all Siberia proper the ratio of women to men is 50.9 to 49.1. In the Buriat-Mongol republic the members of the sexes, however, are almost equal. East of the Baikal the male population is still in excess. In the Far Eastern republic the ratio is 52.5 to 47.5. In the Yakutsk republic the ratio of men to women is 54 to 46, whereas in 1897 it was 51.9 to 48.1. The decline in the proportion of women is to be ascribed to the high mortality among women in their prime, the cause of which is now being investigated. In general it may be observed that the recent loss of man power has overburdened woman with work with injurious effect.

Climatic and historical factors affect most broadly the distribution of the sex ratio. As to the influence of the racial and economic factors the census returns have not yet been sufficiently worked out for analysis, though this is contemplated as one of the first problems to be treated by the Academy of Sciences.

Geographical Distribution of Population

The geographical distribution of population in Russia has depended on three major factors: climate, natural fertility of the soil, and the direction of the colonization movement. The net result has been a settlement very far from uniform: it differs from that of Western Europe in the existence of sharply alternating belts of densely inhabited and uninhabited tracts. Such a distribution cannot be properly shown on statistical cartograms, which usually are based on extensive administrative areas.

For an adequate presentation I have resorted to what I call the "dasymetric" map. Thanks to the active coöperation of Professor

P. A. Palchinsky and the Scientific Institute (for the study of "Surface and Mineral Resources") under his charge, such a map, "Dasymetric Map of European Russia," is in course of publication under my direction.[1] It is based on the 1897 census, with revisions up to 1915, and is on a scale of 1:420,000. Up to date more than 40 sheets have appeared. A new dasymetrical map of the whole Union on the scale of 1:1,000,000 for the European area and the Caucasus, of 1:2,000,000 for the more densely populated southern half of the Asiatic portion, and of 1:4,000,000 for the whole Union, based on the data of the 1926 census, is now being prepared by the Academy of Sciences under my editorship and will appear in the course of a few years.

TYPES OF SETTLEMENT IN EUROPEAN RUSSIA

On the basis of the studies for my book "Town and Village Life in European Russia" (1910) and the dasymetrical map I recognize ten different types of settlement on the Russian plain. Three of these are widespread.

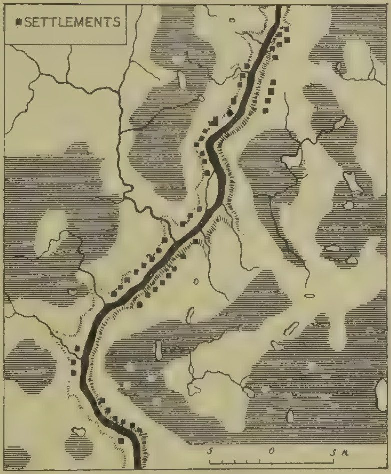

FIG. 7—Type of settlement in the north, i. e. in the valleys and along the waterways. This is a part of the valley of the Northern Dvina with a population density of 70 per square kilometer in the inhabited area.

Settlement in the northern belt is preëminently concerned with the collective industries—hunting, fishing, and extraction of the forest products; only in small degree is it agricultural. Settlements occur exclusively in river valleys and on the shores of lakes and seas, while the watersheds with their peat bogs remain entirely uninhabited. This type is well developed throughout the basin of the northern Dvina, Onega, and other northern rivers.

Settlement on the central watershed region on glacial soils is characterized by the cultivation of flax and cereals. Here the valleys are very humid and the frost season of long duration; hence the population prefers small sheltered villages on the clayey morainic hills and hillocks, warmer and drier but still with the ground water at no great depth. On an average the season for ripening of field crops is ten days longer on the higher land than in the valley bottoms. This type is found in the northwest of the Russian plain and in the center between the Volga and the Oka.

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[1] See the review by Professor Sten De Geer (*Geogr. Rev.*, Vol. 16, 1926, pp. 340–341) in which he makes comparison with his own dot method. Professor Max Friedrichsen in "Die dasymetrische (dichtemessende) Karte des Europaischen Russlands," *Petermanns Mitt.*, Vol. 70, 1924, pp. 214–215, and Professor Palchinsky in the journal *Poverkhnost i Nedra* (*Surface and Mineral Resources*), Vol. 4, 1926, pp. 50–55, also discuss the matter and point out the suitability of my method to conditions obtaining in Russia.

Settlement of the southern type occupies the valleys of the black earth region of wooded and grass steppes. Agglomerations are considerably larger and are situated on the high and often precipitous banks of streams, safe from inundation by the melting snows of spring. In places the settlements practically adjoin, so that they seem to form a narrow band stretching for tens of kilometers and making it difficult to distinguish where one ends and another begins. And yet the inhabitants when compelled to move through stress of growing numbers very unwillingly take to the watersheds, preferring emigration to Siberia or the northern Caucasus. Settlements of this type may be attributed initially to the conflict with the Asiatic nomads who grazed their herds on the vegetation of the watersheds and drove the settlers to the wooded valleys. Now the population does not care to dig the deep wells that are necessary to reach the ground water far below the surface.

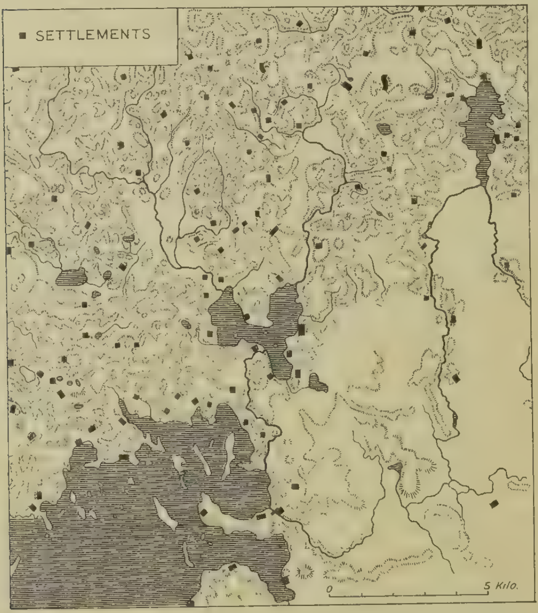

FIG. 8—Type of settlement in the northwest of the Russian plain, on morainic hillocks. In the inhabited area the population density is 22 per square kilometer.

The other forms of settlement are: the highroad type on causeways and ancient highways; the railway type, near railway stations, commercial or summer-residential in character; health resorts, a variety of the summer-residential type; the factory type of industrial districts; the metallurgical and mining type of the mining districts; the fishing type; the southern orchard type on the slopes of the Crimea and the Caucasus, where conditions are specially favorable to the growth of fruit trees.

DENSITY OF SETTLEMENT

On the whole the density of settlement on the Russian plain increases regularly from northwest to southeast. In the glaciated districts of the northwest with slightly dissected relief the average is 30 to 100 inhabitants per settlement; on the clay tracts bordering on the black earth zone from 100 to 200; on the black earth zone 200 to 600 and frequently more, up to 1000. The limit of the black earth is at the same time that of large settlements *en masse*. The largest settlements of this zone, though numbering more than 10,000 inhabitants in individual cases, nevertheless often retain a purely rural character and cannot be ranked as towns. This peculiarity, as Woeikov has pointed out, also occurs in Hungary, Sicily, and the Balkan countries with similar agricultural character.

In Russia dispersed settlement has always met with some or other obstacle, natural or historical. To the former category should be assigned the depth of the water table on the watersheds of the southern half of the Russian plain and the winter frosts with snowdrifts which compel the people to congregate in rather large settlements for mutual warmth and protection. To historical causes may be referred the necessity of defense from the nomads as well as the unwillingness of the communes to allow their members to settle on independent plots. In the forest zone, where the forest is itself a shelter from the cold winter winds, the settlements are smaller, but the danger of losing cattle from wild beasts has in this case also caused close settlement.

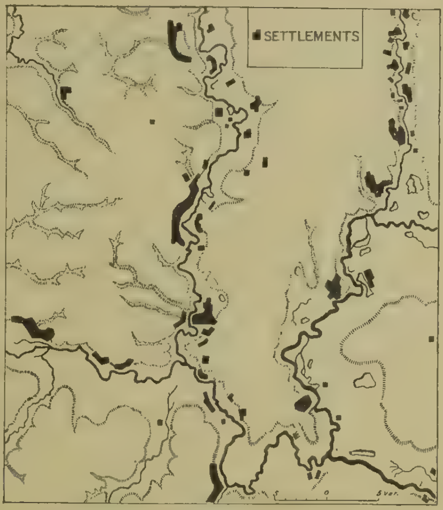

FIG. 9—Type of settlement in the steppes, on the stream banks. Density of population in the western valley 300, in the eastern 500, per square kilometer.

The northern limit of the black earth zone generally forms the boundary between the watershed type of settlement and the ribbon-like valley type; and about the boundary is the zone of densest village population on the Russian plain, extending from Podolia to the estuary of the Kama, which I call the principal axis of colonization because it yields the greatest number of emigrants to the Asiatic part of the Union and to the northern Caucasus.

The American economist Carey[2] formulated a law regarding the pioneer: that agricultural settlers in colonizing a virgin country do not at first occupy the most fertile soils but those that can the most easily be worked with the tools available to them. This law has proved true in relation to Russia. Even now the densest population is not to be found on the black earth of the steppes but on the less fertile clay soils near the northern limit of the zone. Only as these soils have become exhausted through continuous cropping has the population moved southward into the black earth steppe proper. In the country of clay soils the growing population has turned to industry. Here in the geographical center of the Russian plain originated the Moscow industrial district, which has politically assimilated the whole plain and occupied Siberia.

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[2] H. C. Carey: The Past, the Present, and the Future, Philadelphia, 1848.

The Development of Towns

In the history of the development of towns in Russia four periods may be distinguished. In the first, or ancient, period the towns were exclusively founded as military settlements. For the most part they were surrounded by wooden turreted walls and ditches. Because of the abundance of wooden fences in ancient Russia the Scandinavian writers till the fourteenth century called Russia "Gardhariki," the country of fences. From the wooden town walls in the direction of the radiating roads extended the settlements of the soldiery. The greater number of towns being of military origin, they still have a concentric form with radial streets. The center, if built of stone, has retained the name of Kreml, "keep," as for instance in Moscow, Nijni Novgorod, and Smolensk.

During the middle period of town development western Russia gradually annexed lands belonging to the Polish-Lithuanian realm, where town settlements enjoyed the Western European medieval rights under the "Magdeburg Law," with privileges in trade and handicrafts, and where Jews were allowed to settle. Thus in Russia for the first time appear chartered towns. They are easily recognized by the tiled roofs of their buildings. They did not spread farther east.

The modern period commences when the Moscovite state became the Russian Empire, in the beginning of the eighteenth century, and when the interior of the country was now so secure that there was need for administration centers rather than military outposts. By that time nearly all the ancient wooden fortifications had disappeared, and many concentric towns had been transformed on a rectangular plan with a central market square, in which was situated the stone cathedral, surrounded by administrative buildings generally also of stone. The houses of the ordinary citizenry were still mostly wooden with iron or shingle roofs.

In the latest period, beginning in the nineteenth century, industrial towns began to arise; and in the second half of the century, commercial towns along the railways. Thus the principal stations of the old railway line between Petersburg and Moscow have during the 77 years existence of the line all become towns, and in their neighborhood many other small towns and boroughs have arisen.

The towns of Siberia, like those of European Russia, were first founded with purely military and administrative aims and had a similar appearance, but their population displayed a peculiarity in that it consisted of political and criminal convicts who afforded a supply of free labor for any kind of work. Many Siberian towns had been originally founded in haste to insure a greater hold over the natives: when they were no longer needed for that purpose and were situated unfavorably as regards geographical conditions, they simply disappeared. Potanin notes some curious features in the influence of trade on the Siberian towns. In western Siberia commerce was chiefly in cheap and bulky farm produce, such as grain and leather; whereas in eastern Siberia it was chiefly in expensive, light-weight goods, such as gold, fur, and tea. The merchants of western Siberia, before the building of the Trans-Siberian railway, restricted their annual journey to the fair of Irbit on the Ural and other Ural towns; while the merchants of eastern Siberia made longer journeys to the more highly civilized centers of European Russia—Petersburg, Moscow, the fair of Nijni Novgorod; which procedure was reflected in the greater degree of civilization in the towns of the east notwithstanding their greater distance from European Russia. Civilization here was also promoted by the Decembrists, exiled in the twenties of the last century in great numbers to far eastern Siberia.

The general conditions of the towns of the Russian plain and Siberia are still on a considerably lower level than those of western Europe; and they have not improved in the last 12 years, for many buildings that were destroyed have not yet been restored.

A particular type of town is represented by those of the southern mountainous countries belonging to the Soviet Union. In the Crimea and on the northern slopes of the Caucasus many towns are garden cities, thanks to their function as health resorts. In most of the towns of Transcaucasia the rural character of the population predominates, especially in Kolchis, central Armenia, and Azerbaijan, although it is just in these parts that the largest centers are situated—Tiflis and Baku. The towns of Transcaucasia have a rather pronounced eastern character, and with the exception of the greater number of the newly built towns on the Black Sea between Novorossiisk and Batum, which have an entirely European aspect, they are not distinguished for cleanliness.

Towns in Turkestan

Slavonic colonization on reaching Turkestan found numerous populous ancient towns of the type of Samarkand, Tashkent, Bukhara, Khiva, and the like in the oasis of the river valleys. Without infringing on their integrity the Russian authorities founded side by side with the native towns spacious Russian settlements of the garden-city type. Also, for administrative purposes, a series of new towns, originally purely Russian, was founded in former wastes, such as Vernyi, Askhabad, Krasnovodsk. When the Central Asian and Tashkent railways had been built and artificial irrigation increased, colonists from the Russian plain were induced to emigrate thither, whence these towns acquired a new economic importance and grew rapidly. In the former Khanates of Bukhara and Khiva, which attracted few Slavonic colonists, the town population was less numerous. With the exception of Bukhara there were then no big towns, though the number of towns in both these Khanates, reaching as many as 35 to 40 in comparison with only 100 towns in the whole of Asiatic Russia, must be considered large. Here rural Asia, according to Woeikov's expression, has made itself felt. The native towns of central Asia have on the whole a rustic appearance, are dirty and crowded, and have but few stately monuments of Moslem antiquity: they contrast sharply with the adjoining Russian garden towns.

Classification of Towns

After the Revolution a considerable change was made in the official classification of towns. Now every place in which industrial life is developed, though it may have fewer than a thousand inhabitants, is regarded as a town. A distinction, however, is made between a "town" and a "settlement of the town type." A greater number of fairly populous towns have made their appearance, of which nobody formerly was aware; but, as the names of many of these places have also been changed without their previous names being indicated in the official records, it is a matter of extreme difficulty to compare them in detail with their originals.

Increase of Town Population

The town population of the Soviet Union according to the census of 1926 amounted to 25,734,418 persons, or 17.6 of the total population. In 1897 the returns gave the town population, which included their suburbs, as 13 per cent. This calculation, however, fell below actual conditions, since many important centers of the town type were ignored in the official list. In my book "Town and Country in European Russia" (1910) I attempted to introduce the necessary correction for European Russia without Finland and Transcaucasia, whence I obtained 15 per cent, beside which 3.5 per cent constituted a semi-municipal population and 31 per cent that part of the entire population that was engaged in other than rural occupations. As in the Asiatic part of Russia, which did not enter into my calculations, the town population was less developed, the general percentage of the town

TABLE I—THE PRINCIPAL TOWNS OF RUSSIA: POPULATION IN 1897 AND 1926*

	1897	1926	PER CENT INCREASE
1. Moscow	1,035,664	2,018,286	95
2. Petersburg (Leningrad)	1,267,023	1,611,103	27
3. Kiev	247,432	493,873	99
4. Baku	112,253	446,832	298
5. Odessa	405,041	411,111	1.5
6. Kharkov	174,846	409,505	134
7. Tashkent	156,414	320,865	105
8. Rostov-on-Don	119,889	304,812	154
9. Tiflis	160,645	279,565	74
10. Saratov	137,109	211,765	54
11. Ekaterinoslav (Dniepropetrovsk)	121,216	187,644	54
12. Nijni-Novgorod	95,124	181,189	90
13. Kazan	131,508	174,732	33
14. Samara	91,672	171,952	88
15. Ekaterinodar (Krasnodar)	65,697	161,965	146
16. Omsk	37,470	161,475	328
17. Astrakhan	113,001	152,543	35
18. Tula	111,048	149,172	34
19. Tsaritsyn (Stalingrad)	55,967	147,184	163
20. Ekaterinburg (Sverdlovsk)	55,488	134,356	143
21. Minsk	91,494	123,613	35
22. Orenburg	72,740	121,975	68
23. Novo-Nikolaevsk (Novo-Sibirsk)	5,000	120,611	2310
24. Voronezh	84,146	116,576	39
25. Yaroslav	70,610	112,103	59
26. Ivanovo-Voznesensk	53,949	111,114	106
27. Tver	53,477	105,714	98
28. Yusovka (Stalin)	32,000	105,706	230
29. Vladivostok	28,896	102,454	254
30. Samarkand	54,900	100,182	83

*For location see Figure 4.

population of the Empire would be somewhat lower than the 15 per cent but in any case higher than the official 13 per cent.

Since the year 1918 the thickly populated territory in the west, with a considerable part of its population town dwellers, has been separated from Russia. Moreover, immediately after the Revolution not a few townspeople deserted the towns for the villages. Yet it appears that the percentage of town dwellers is higher than it formerly was. This may be accounted for by the present federative organization of Russia, local autonomy requiring a considerably greater number of administrative centers. The newly formed or enlarged town centers attracted the town population back from the country and gave them

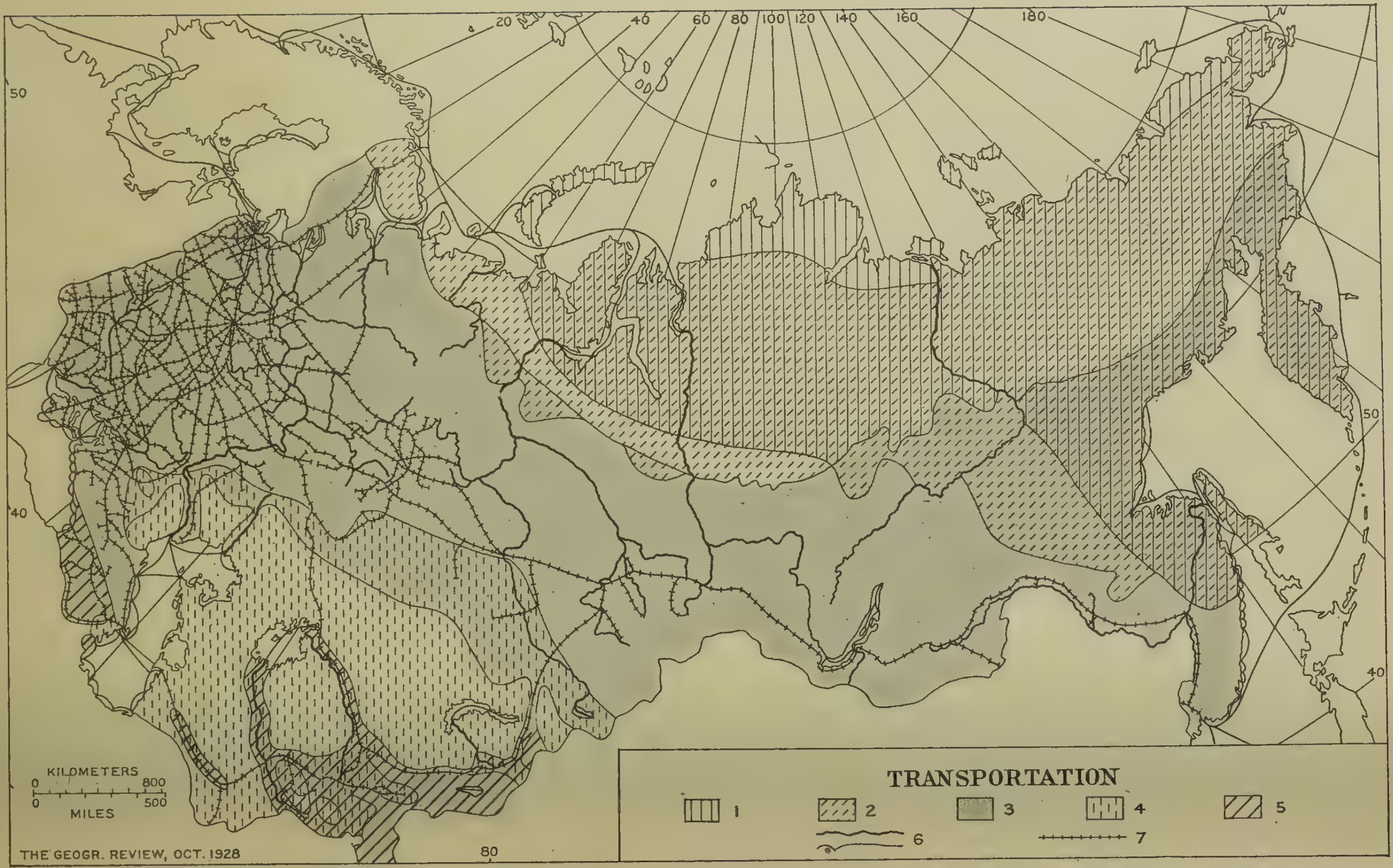

FIG. 10—Means of transportation, compiled by B. Semenov-Tian-Shansky. 1, dogs; 2, reindeer; 3, horses and oxen; 4, camels; 5, mules, asses, and buffaloes; 6, principal lines of navigation on rivers and seas; 7, railways.

work. Suburban settlements at the beginning of the Revolution were completely deserted and partly destroyed, but during the years 1923–1926 their population increased 39 per cent in consequence of the housing crisis. Workers' settlements increased by 38 per cent at the same time, and settlements along railways and waterways as well as industrial towns by 32 per cent. The mean growth of the population of all towns of the Union for that period was 24 per cent, or an increase of 6 per cent a year. The town population is greatest in the central region, with an offshoot towards Leningrad, and in the southern and the Ural regions (see Fig. 4).

Immediately after the October revolution of 1917 the population of Petersburg fell to 700,000, and a considerable number of the wooden houses on its outskirts were torn down and used as fuel. Now the population has again increased to over 1,600,000 and continues growing, but meanwhile the present capital Moscow has taken first rank. Kiev and Baku likewise have overtaken Odessa, which, owing to the decline of its commercial port since 1914, shows the smallest increase of all the large towns. The record in growth may be accorded to Novo-Nikolaevsk with 2310 per cent, which after the Revolution, under the name of Novo-Sibirsk, has become the principal administrative center of Siberia and its largest railway-and-waterways junction. It is situated on the Ob in the center of the black earth region north of the Altai plain, the most densely populated in all Siberia. As late as the year 1895 on the site now occupied by Novo-Nikolaevsk grew a pine forest with a forester's cottage where I chanced to spend a night. Since the census the rapid growth of the town continues, and in the neighborhood small wooden houses often spring up in the course of a single night. By its growth Novo-Nikolaevsk retards that of its neighbor, ancient Tomsk (92,485 in 1926), the geographical situation of which is less favorable, and has all but smothered another ancient town, Kolyvan on the Ob (8000). Next in rapidity of growth is Omsk, also a railway-and-waterways junction on the Irtysh. In eastern Siberia, which is more thinly populated, the growth of towns has not been so rapid; so far none has reached 100,000, though Irkutsk is not far short (98,979). On the Pacific, Vladivostok exceeds 100,000. Generally speaking the Siberian towns and those on the borders of the Union grow more rapidly than those of old Great Russia, as is the general rule in any colonizing process. Within European Russia Yuzovka, in the basin of the Donets, with its metallurgical works exhibits the most rapid growth.

Communications as Affecting Population Spread

The gradual occupation of the territory of the Soviet Union by Slavic agriculturists was accomplished when ways of communication were very poor. Through a third of the territory transport is still effected by means of dogs and reindeer, through about one-sixth by camels, through about one-half by horses and oxen, and in quite an insignificant part of the southern territory by mules, asses, and buffaloes. On Western European maps, it may be remarked, the northern limit of the range of the ass in Russia is generally shown too far north, where it cannot endure the severity of the winter. A more or less considerable network of railways is developed only in the western part of the territory, within the range of the horse, while some two or three trunk lines provide for the needs of the remaining area. Rivers freeze over for a large part of the year throughout the greater extent of the Union, and little has been done towards connecting them by canal. The vast Siberian rivers inconveniently fall into the Arctic Ocean, a dead sea: and even the best water artery of the Union, the Volga, flows into a closed salt lake, called "sea" by courtesy. Communication by motor, owing to the bad state of the unmetalled roads, is feebly developed: according to official information the country possessed only 12,000 motor vehicles in 1927 (in 1928 the United States had over 23,000,000 motor vehicles). The colonization of these vast spaces therefore deserves the greater credit.

House Types

Slavonic colonization of the Eurasian continent, peculiar for its severe winters, has produced in the course of many centuries types of small but warm dwellings heated in winter with wood in the forest-clad north and with straw and dry dung in the southern treeless steppes. These dwellings are built of wood with shingle roofs in the north, of wood roofed with thatch in the center, of clay and earth, covered with thatch, reeds, or earth in the south. Transition from such types to those of Western Europe has been accomplished slowly and unwillingly, especially the transition to several-storied buildings, in which the heating problem is much more difficult. For this reason and because of the general poverty of the people the towns of the Union, except the largest, often possess a considerable number of rural buildings, creating an aspect very different from that of the towns of Western Europe.

Some Relationships between the Members of the Soviet Union

The Soviet Union encloses within its bounds vast spaces that are thinly inhabited by native trappers of the forest or steppe nomads, from whose mode of life native towns could never spring. But now, with the introduction of the autonomous federative organization, towns are needed even here. The only expedient for the local population, therefore, was to utilize such Russian towns as already existed on the borders of their territories. These have been made into capitals, their names being changed according to the local taste. Thus the Zyrians made the small Russian border town of Ust-Sysolsk (8000 inhabitants) the capital of the republic, Komi; the Kirghiz in the republic Kazakstan did the same with the Russian border town of Perovsk (22,000), giving it the name of Kzil-Orda; the town of Vernyi (45,000) has had its name changed into Alma-Ata; the capital of the Bashkir republic is the large Russian town of Ufa (97,000), and so on. The Western European might be inclined to regard such facts as denoting decolonization, but in fact they are rather features of a novel peaceful symbiosis.

Similiarly, although no general compulsory official language has been declared, the international language within the limits of the Soviet Union and consequently the general language of the Union remains Russian. At the same time every one of the united republics and autonomous provinces uses its own state language for its own needs. As the greater number of these units hitherto had either no literary language or one little developed, an active manufacture of such languages is now in progress.

Great efforts are also being made to promote regional survey. The newly formed republics of Yakutia, Kazakstan, Bashkiria, Karelia, Buriatia have spontaneously requested the Federal Academy of Sciences in Leningrad to institute a thorough investigation of their territories and population by Russian scientists at their own expense. The Federal Geological Committee in Leningrad is exploring the mineral resources of all countries within the Union; the Central Statistical Administration in Moscow coöperates with the local statistical bodies of all the republics, amongst other functions conducting the federal census: this was accomplished by means of the local statistical institutions of the separate republics, returns being made in the local languages. The Planning Committee of the Federal State in Moscow projects economic measures for all the republics, as for example electrification, communications. Hence, and also because of the contrasted natural character of the federal republics constituting the Union, their relations are founded on the principle of mutual help in their economic life.

The human agglomeration of the 146 millions inhabiting the Soviet Union originated and has grown under difficult conditions, climatic, historical, and economic, and has always been distinguished by its lack of stable equilibrium. Yet it has always managed its internal affairs independently of foreign interference, and, as has been well pointed out by Woeikov, nowhere in the world but in Russia and China has internal trade played so important a part in the economic life of the country.

The Russian geographer Silinich has justly observed that before the World War imperialism in Russia was purely geographical, consisting in the search for natural physical boundaries, and not economic or national as was the case with other European states. Having acquired extreme mobility in sustaining so long a conflict with nomads, Russia in the course of time, when its interest clashed with those of other states, yielded territories which it had occupied with the ease that characterizes the nomad. Historically Russia has confined itself, according to the expression of our greatest poet Pushkin, "to cutting windows" looking out on the never freezing seas. But our people's chief energy has been spent colonizing the vast thinly populated country and struggling with its rigorous natural conditions.

Russia has always had and still has its own Eurasian interests which are neither purely European nor purely Asiatic. One of these interests was the pacification of the aborigines and reconciliation of the nomad tribes with the agriculturists. The problem has been solved successfully, and the former rivals have become friends; they have managed to draw boundaries between their territories so as not to hinder each other, and the nomads have gradually begun of their own free will to turn to the once hated occupation of husbandry whose tools they used in the old days to destroy, annihilating entire well irrigated districts.

The general trend of that colonization as here set forth is so worthy of respect as to call for general sympathy. If to this be added the heroic struggle with rigorous natural conditions, the feat performed by the eastern Slavic colonization stands out the more prominently in the history of humanity. It was not altruism that guided reconciliation with the savage aborigines but the extremely harsh natural conditions, which involuntarily unite people in their struggle against nature and lead them to mutual assistance.

THE POPULATION OF ANCIENT AMERICA

H. J. Spinden
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[With separate map, Pl. VII, facing p. 660]

WHAT is the Indian population in America today, and is it increasing or decreasing? Was it as large in 1492 as it is now or as it had been in some earlier period of New World history? These questions I hope to answer not so much with statistics as with suggestive considerations. Indeed, exact figures are not available even for the proportion of Indian blood in the present population of America, and it is obvious that the speculative factor must become larger and larger as we pass back through the centuries.

PRESENT INDIAN POPULATION

The present Indian population in the New World is much larger than most persons might imagine from their knowledge of conditions north of Mexico. For Greenland, Canada, Alaska, and the United States the number is less than 400,000, with considerable admixture of foreign blood for which a proportional discount must be made. For the United States the most reliable count of Indians was the census of 1910, which found 265,683 individuals. Of this number 150,053 were full bloods, and the others mixed bloods with a distinct leaning towards white. The census of 1920 showed a reduction of 21,246 from the figures for the preceding decade. The counts made by the Bureau of Indian Affairs differ widely from those of the general census, since in some cases persons with one sixty-fourth part Indian blood are called Indians. Also the tribal rolls used by the Bureau, in spite of various purgings, carry a large number of negro "freedmen" who may or may not have old American blood. For 1920 the aboriginal population according to the Bureau was 336,379, or 91,942 in excess of the census of that year. Fluctuations, explained mainly by reorganization of the rolls, are apparent in the following totals for different years:

1870	313,712	1887	243,299
1877	276,540	1900	270,540
1885	344,064	1926	349,964

Probably the Indian strain in the United States, counting proportional values only, is equivalent to about 200,000 individuals of pure blood, with claims of recent increase unjustified. The Navajo and one or two other tribes have more than held their own, but except for these a general decrease is indicated.

What a difference when we turn to Mexico! There the census of 1900 found a total of 13,605,819 inhabitants, classified as 19 per cent whites, 38 per cent Indian, and 43 per cent mixed bloods. The census of 1910 gave the total as 15,160,369, but by 1920 this had receded to 14,234,852, perhaps as a result of civil war and emigration. It is difficult even to estimate the proportion of Indian blood in the total population of Mexico, since classification is formed on the language basis. The statistical Indian is one who speaks an Indian language, generally to the exclusion of Spanish.

We have one excellent study of a special region, the Valley of Teotihuacán, which was made by the Department of Anthropology of the Mexican federal government.[1] The total population of the Valley of Teotihuacán is 8330, of which 6825 are of local origin, 1477 come from other districts of Mexico, 10 are foreigners, and 18 unclassified. In the matter of race 5657 are Indians, 2137 are mixed bloods, and 536 are whites. But of the total, 7860 speak Spanish; 448 both Indian and Spanish; while 7 speak only an aboriginal tongue. The proportion of Indian blood in this instance is almost 80 per cent; but whether or not this proportion would hold true of all Mexico is another question.

Indian community life and language are preserved in many regions of Mexico to a much greater extent than in the Valley of Teotihuacán. The statistics on native tongues are not reliable, but according to the census of 1900 they are spoken by 3,971,434 individuals. Playing safely within the estimates of several observers but remembering the high proportion of Indians who have lost their native speech, we conclude that the Indian blood in Mexico is equivalent to a pure population of at least 10,000,000 souls.[2]

Other Central American and South American countries where the Indian forms a very high percentage of the total population are Guatemala, Salvador, Honduras, Colombia, Ecuador, Peru, and Bolivia. Elsewhere the proportion is always considerable even in the cases of Argentina and Chile, which fail to make adequate return in their censuses of such Indian blood as does survive among accultured aborigines.

Always making allowance for mixed bloods at proportionate value, we summarize thus:

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[1] Manuel Gamio: La población del valle de Teotihuacán . . . . 2 vols. in 3, Department of Anthropology, Mexico, 1922; Reference in Vol. 1, Pl. II and pp. xxii–xxiv. In the English summary, "Introduction, synthesis and conclusions of the work, The Population of the Valley of Teotihuacán" reference is Pl. III and pp. xxi–xxiii.

[2] If the "mixed race" classification of the Mexican census be taken as half Indian we have nearly 70 per cent for the total of Indian blood, but it is obviously more than half Indian.

North America north of Mexico	350,000
Mexico	10,000,000
Central America	2,500,000
Colombia and Venezuela	3,000,000
Ecuador, Peru, and Bolivia	6,000,000
Brazil, Paraguay, Uruguay, and Guianas	4,000,000
Argentina and Chile	200,000
West Indies	
	26,050,000

This gives a conservative minimum of 26,000,000 for the red race at the present time.[3] We now look into the past and consider the evidences of population, first at the coming of Europeans, and then on more ancient levels of the native civilizations.

THE DEPOPULATION OF THE WEST INDIES

In the West Indies hardly a drop of the old American blood can now be found. Indeed, the Spaniards had scarcely set foot on the teeming islands before the native population melted away. Santo Domingo was colonized in 1493, Porto Rico and Jamaica in 1509, and Cuba in 1511. Las Casas in his famous "Brief Relation" says in regard to Porto Rico and Jamaica:[4] "Whereas there were more than three million souls, whom we saw in Hispaniola, there are today, not two hundred of the native population left." He was writing no later than 1542. Elsewhere Las Casas places the population of Porto Rico at 800,000 and that of Santo Domingo at 3,000,000. These are doubtless extravagant estimates. However, on the basis of personal surveys of many archeological sites in Porto Rico I postulate a population of at least 100,000. Santo Domingo, a much larger island, is archeologically almost unknown; but, since characteristic remains of the ancient Taino culture[5] extend from Porto Rico across Santo Domingo to the eastern end of Cuba, the total population of the Taino nation may easily have been a million. It is clear that Cuba, except for the region about Cape Maisi, was scantily peopled. Jamaica and the Lesser Antilles offer considerable evidence of ancient human habitation but not of a kind permitting even a rough estimate of numbers.

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[3] Karl Sapper in "Die Zahl und die Volksdichte der indianischen Bevölkerung in Amerika von der Conquista und in der Gegenwart" (*Proc. 21st Internatl. Congr. of Americanists Held at The Hague, Aug. 12–16, 1924*, Part I, pp. 95–104) estimates the present (1910) Indian population of America at between 15 and 16 millions and that at the end of the fifteenth century at between 40 and 50 millions. The paper is summary in form and undocumented. Sir Harry Johnston in "The Negro in the New World" (1910) estimates at "20,855,000 hybrids between the white and the Amerindian" and "16,000,000 of pure-blood Amerindian and Eskimo" in the New World (p. 484.)

[4] F. A. MacNutt: Bartholomew de Las Casas, his Life, His Apostolate, and His Writings, New York, 1909, p. 316.

[5] J. W. Fewkes: The Aborigines of Porto Rico and Neighboring Islands, *25th Ann. Rept. Bur. of Amer. Ethnology, 1903–04*, Washington, 1907, pp. 3–296. M. R. Harrington: Cuba before Columbus, Part I, Vol. 1 (Indian Notes and Monographs, Misc. Ser., No. 17), Museum of the American Indian, Heye Foundation, New York, 1921.

IMPORTED DISEASES AS A FACTOR IN DEPOPULATION

Even if we take Las Casas' estimates at one tenth their values, the eradication of the natives in a generation is difficult enough to explain. This could not have been accomplished by wholesale slaughter with the sword, considering the available forest cover and mountain retreats, but it might have been accomplished by epidemics of new diseases which searched out native villages far beyond the Spanish lines. Early mortality among the Indians is mentioned by Oviedo and other chroniclers. It seems that the so-called colonization of Santo Domingo was first of all a gold rush, with the natives suddenly exposed to a host of new diseases and to a condition of slavery under a heterogeneous and undisciplined mob. While starvation and these new diseases were probably the most active agents of sudden decrease in population, nevertheless the situation was commanded by a policy of frightfulness which caused a social collapse so complete that even the victors nearly perished of famine. The Spaniards gave no thought to planting crops, intent only on a fevered turning over of the ground in search of the yellow metal.

Devastating diseases pretty clearly of New World origin are syphilis and yellow fever.[6] To the first of these the agricultural Indians, especially those of Peru, Mexico, and the West Indies, had developed considerable immunity. Yellow fever was endemic in the Atlantic lowlands of Mexico and Central America, occasionally invading the highlands.

Europeans unloaded upon American Indians a tremendous burden of new infections for which the latter had not the slightest immunity. Perhaps smallpox comes first as an introduced plague and measles second, this latter malady being very deadly for the red man. But in the tropics the debilitation and mortality resulting from the introduction of malaria in three types and hookworm in two are heavy factors. There have been great epidemics of several other diseases, including Asiatic cholera. In recent years trachoma has been a burden among many tribes. High mortality among the aborigines has generally followed the opening up of new territories by the white men.

The small number of serious forms of disease in pre-Columbian America is explained first by the independence of New World civilizations. We must picture the tenuous connection between the hemispheres, consisting of nomads passing via Siberia and Alaska, as insufficient for the transmission of such pathological organisms as might already have attacked the thicker settlements of the Old World.

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[6] Anthropologists have long insisted that syphilis was of New World origin, but the medical world after disputing the evidence is now accepting it. The case for the American origin of yellow fever is equally strong. This disease was implanted in Africa by slave traders, and some medical opinion now leans inconsistently to Africa as its cradle land (H. J. Spinden: Yellow Fever—First and Last, *World's Work*, Vol. 43, 1921, pp. 169–181).

Furthermore, few gregarious animals were brought under domestication in America to prove new sources of malevolent infection.

THE TEN PLAGUES OF NEW SPAIN

In Mexico the Spaniards struck sharply and deeply, while illusion of their divinity and magic power still obsessed the aboriginal populace. Nevertheless, they might easily have failed if reinforcements of invisible parasites had not come up in time. Between the retreat of Noche Triste and the final taking of Tenochtitlan smallpox fought most valiantly on the side of the invaders and finally turned the battle definitely in favor of Christianity.

Friar Toribio de Benevente, commonly called Motolinia, arrived at Vera Cruz in May, 1524, and his "History of the Indians

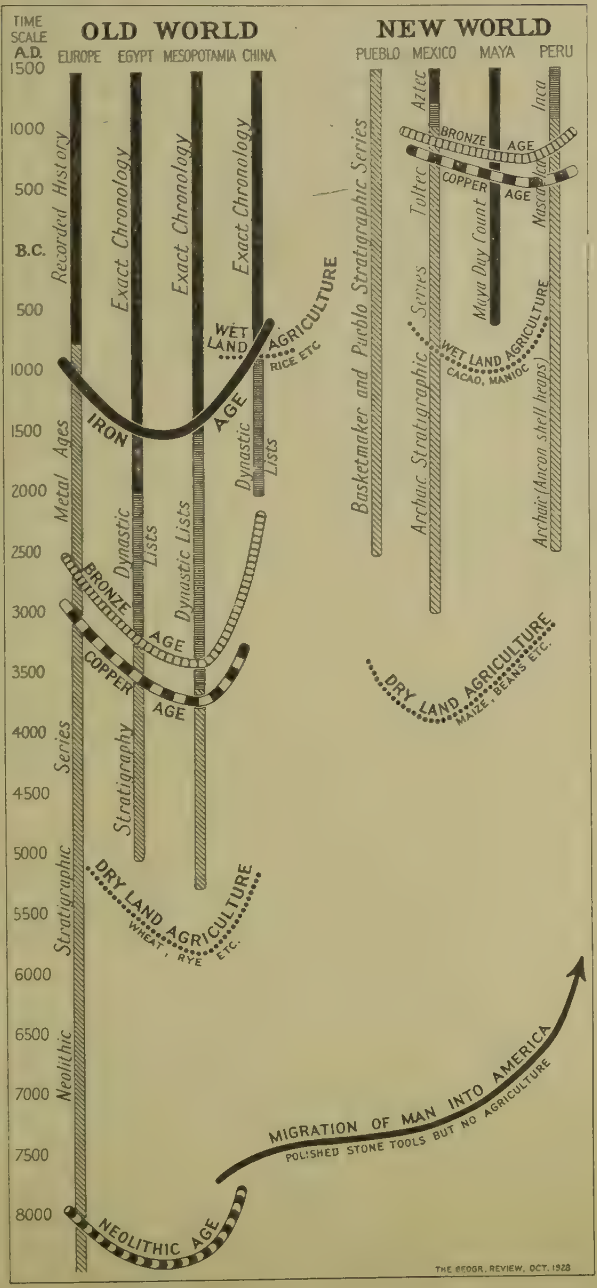

FIG. 1—Chronological and economic diagram of the parallelism between Old and New World civilizations which presents in summary form some of the facts bearing on the question of the population of ancient America. Note that the stratigraphic series of Europe is only carried back to the horizon of polished celts. Before this come the Mesolithic and Paleolithic series which are not represented in the New World.

of New Spain" was finished in 1541.[7] He draws a tremendous picture of events and conditions which reduced the native population by comparing Ten Plagues of New Spain with the biblical Ten Plagues of Egypt. I cannot give the gist of depopulation better than by using the words of this priest:

> God smote and chastized this land and those who found themselves in it, natives as well as strangers, with ten burdensome plagues.
>
> The first was smallpox, and it commenced in this manner. Hernando Cortes was captain and governor when Captain Panfilo de Narvaez disembarked here, and in one of his ships came a negro suffering from smallpox, a disease never before seen in this land. Then this New Spain was full of people to the extreme and as the smallpox began to catch among the Indians there was so great a malady and pestilence among them everywhere that in most of the provinces over half of the people died and in others scarcely less.
>
> Eleven years later came a Spaniard with measles which passed from him to the Indians . . . and many died.

Motolinia then gives other "plagues," the second being the heavy mortality at the taking of Tenochtitlan; the third, the famine which resulted from the widespread warfare; the fourth, the abuses of overseers in the towns given in vassalage; the fifth, the heavy tributes; the sixth, the tremendous abuses in connection with the mines; the seventh, the construction of Mexico City by forced labor; the eighth, the traffic in branded slaves; the ninth, the abuses of transportation with Indians as human beasts of burden; and the tenth, the factional warfare among the Spaniards themselves with Indians bearing the brunt of fighting.

The charges of Motolinia were those of a contemporary witness, and they are borne out by legal papers against Cortes, Alvarado, etc., and by such native documents as the Codex Kingsborough. The juggernaut drama was reënacted in Colombia and Peru.

On the Recovery of Indian Populations

The great and sudden falling off in the Indian population during epochs of conquest must be considered in relation to increase or recovery, which in some regions has been notable. In the United States perhaps the most remarkable case of increase over early numbers is that of the Navajo. This tribe secured sheep, became pastoral without much modification of their original wandering life, and in two centuries quadrupled without admixture of foreign blood.

In Mexico also there has been a rapid increase from low records of the Spanish régime, as may be seen by comparing the figures collected by Humboldt[8] with those of today. For 1803 the German traveler makes the population of Mexico 5,837,100; classified as 18 per cent white, 60 per cent Indian, and 22 per cent mixed. The area covered is not exactly the same as that of today; but the state of Chiapas, then counted with Guatemala, serves to counterbalance parts of the Southwest which now belong to the United States. The increase is about 150 per cent in 125 years, and the Indian part of the population seems to hold its own proportionally or perhaps to gain if we eliminate immigrants. The Maya territory in the peninsula of Yucatan is an exception to the general advance. Humboldt gives the population of the political district of Mérida (which seems to have included Campeche) as 465,800 and that of Valladolid as 476,400, making a total of 942,200 for the Mexican proportion of the peninsula.[9] This may have been an overestimate, but a very great falling off resulted from the terrible War of the Castes precipitated by the sending of several shiploads of Maya Indians to Cuba as slaves. This war broke out in 1848 and resulted in abandonment by white landowners of much of eastern and central Yucatan. Parts afterwards pacified were never able to retrieve the earlier prosperity.

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[7] (Fray) Toribio de Benavente o Motolinía: Historia de los Indios de la Nueva España, Barcelona, 1914; pp. 13–14. For another important reference on depopulation see Juan López de Velasco: Geografía y descripción universal de las Indias: Recopilada por el cosmógrafo-cronista Juan López de Velasco desde el año de 1571 al de 1574, publicada por el primera vez en el Boletín de la Sociedad Geográfica de Madrid, con adiciones é illustraciones, por Don Justo Zaragoza, Madrid, 1894, p. 26.

Of Guatemala in 1778 Juarros[10] says:

> The larger and principal part of these lands was captured by Captain D. Pedro de Alvarado in the year 1524 and following. In that time these countries were much more populated than at present since according to the count made by order of His Majesty in the year 1778 this kingdom has no more than 797,214 inhabitants; while in the time of its conquest its inhabitants were innumerable, so much so that they comprised more than 30 nations.

But the Guatemala of Juarros covered all the territory between Mexico and Panama and even included the present Mexican state of Chiapas. Now this area supports about 6,000,000 inhabitants. While part of this total is covered by immigration, a very great increase is generally to be noted for Indians living agricultural lives in open country. I have elsewhere given the present Indian population of Central America in round numbers as 2,500,000. A missionary living on the populous Guatemalan highlands estimates that there are at present 750,000 Indians speaking native languages and maintaining parts, at least, of the ancient culture. These are ranked as peons; and some 300,000 of them are compelled to migrate to the unhealthy coffee regions of the coast for part of the year—a necessity which has resulted in heavy mortality. Others serve as burden-bearers to escape the classification of forced labor. It is possible to demonstrate from the detailed statistics in the surveys of Velasco, Juarros, etc. that the Central American Indians have remarkable vitality in recovering population losses.

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[8] Essai politique sur le royaume de la Nouvelle-Espagne (Voyage de Humboldt et Bonpland, Part III), 2 vols. and atlas, Paris, 1811; reference in Vol. I, pp. 152 et seq.

[9] *Ibid.*, p. 155.

[10] Domingo Juarros: Compendio de la historia de la ciudad de Guatemala (2 vols., Guatemala 1808–18), Vol. 1, p. 8; English transl. by J. Baily: A Statistical and Commercial History of the Kingdom of Guatemala in Spanish America, London, 1823, p. 10.

We need not follow much farther the statistical record of recovery of Indian populations from the lows reached after the incoming of Europeans. The Indian survival in the West Indies is negligible,[11] but it happens that about 5000 so-called black Caribs, former residents of St. Vincent, were dumped in 1793 on the then deserted island of Ruatan by the English for trafficking with the French. They were strongly intermixed with negroes, and today their descendants might be taken for negroes were it not that they talk and live like Caribs. This people now number about 30,000 souls; and their villages stretch from Stann Creek, British Honduras, to Carib Town, Nicaragua.

Evidences of recovery must be taken in conjunction with other evidences of continuing decrease. For instance, the Xicaque, Paya, Sumo, Guatuso, etc. in Central America are fast approaching extinction, and the same holds true of natives of the Putumayo in Colombia who are now concentrated in missions. Similar concentrations in California, Central America, Bolivia, Paraguay, and Chile long since led to complete extinction of many tribes. In Brazil the aborigines suffered heavily in the recent rubber trade, while in Tierra del Fuego sheepmen went so far as to put a bounty on their heads. It seems that sporadic increase still falls short of restoring the Indian population at the advent of the whites. But another matter awaits discussion, namely, crests of population in pre-Columbian times.

Population Peaks under Indian Civilization

The highest civilization of the New World was that of the Mayas, whose great and numerous ruins of stone and mortar exist in a region of rain forests now practically uninhabited. Here we are dealing with a people who invented writing and mathematics in addition to architecture and who left dated records of their achievements on stone monuments which enable us to restore the chronological framework of history. It now appears certain that the Mayas were living in the humid lands at least as early as 613 B. C., when their day count was inaugurated.[12] This means that several arid-land plants, including maize and beans, had already been adjusted to wet conditions. The earliest "contemporary" date found (on the Tuxtla statuette) is 98 B. C., and the peak of the urban civilization of what is called the First Empire falls between 300 and 600 A. D.

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[11] Culin describes a settlement in eastern Cuba which still contains a little Indian blood (Stewart Culin: The Indians of Cuba, *Bull. Univ. of Pennsylvania Free Museum of Sci. and Art*, Vol. 3, 1902, pp. 185–226).

[12] H. J. Spinden: The Reduction of Mayan Dates, *Papers Peabody Museum of Amer. Archaeology and Ethnology, Harvard University*, Vol. 6, No. 4, Cambridge, Mass., 1924.

But by 630 A. D. every one of the great cities had been abandoned. This abandonment may have begun about the middle of the sixth century of our era, judging from the latest dates at several cities. Speculation has been rife concerning its causes. Huntington[13] has developed a theory of climatic change, which does not seem to meet the known facts; and Cook has argued that the Central American savanas are exhausted agricultural lands.[14] But the barren savanas respond to geological conditions without evidence of having been farmed. Moreover, the dates show that cities located on the rich flood plain of the Usumacinta were abandoned at the same time as cities on the shallow-soiled plain of Petén. Warfare does not seem to have been highly developed, for none of the early Maya cities are fortified. Sanitation affords the best explanation, and it happens that yellow fever had its most likely place of origin in Central America.[15]

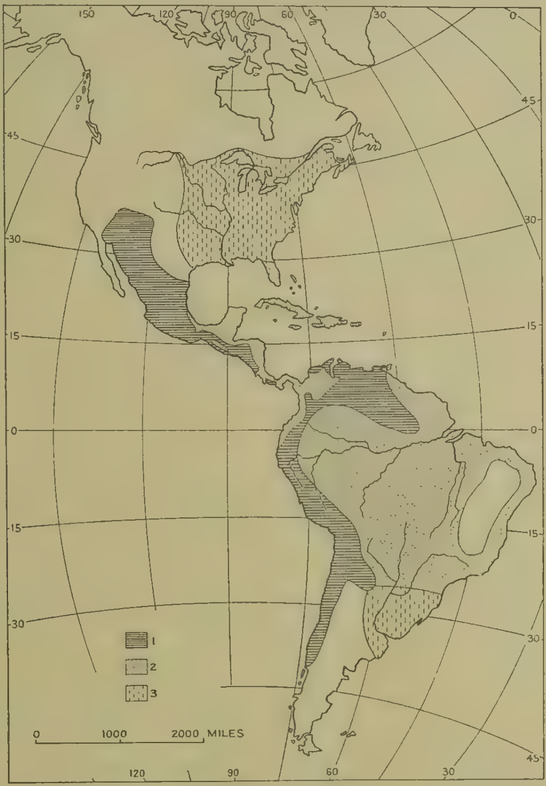

FIG. 2—Distribution of agriculture in the New World in pre-Columbian times. Numbers have reference to agriculture: 1, in arid regions of considerable altitude, mostly with irrigation; 2, under humid lowland conditions; 3, under temperate conditions.

Yucatan and in fact the whole area of the Mayas is a welter of hewn stone and rubble constructions of the most massive character. Yet during the prolific First Empire the Mayas were entirely unacquainted with metals. We must picture them cutting and carving stone with stone tools and carrying the material on their backs or dragging it over the ground from quarry to structure. It is an astonishing fact that there is no evidence of the mechanical use of the wheel in connection with traction anywhere in the New World on any cultural level. Human labor of the most strenuous sort was called for, and the vast accumulations have therefore an important bearing on population. Another fact that has often been overlooked is that the Mayas, lacking the help of draft animals, were also spared the expense. They were not forced to divide their supply of vegetable food or the land available for cultivation with hungry brutes far less economical than human beings.

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[13] Ellsworth Huntington: The Climatic Factor as Illustrated in Arid America, *Carnegie Instn. Publ. No. 192*, Washington, 1914.

[14] Discussed by S. G. Morley in "The Inscriptions at Copan," *Carnegie Instn. Publ. No. 219*, Washington, 1920, pp. 452–457.

[15] The Books of Chilam Balam, Maya chronicles, record pre-Spanish visitations of yellow fever under the name xekik, "blood vomit."

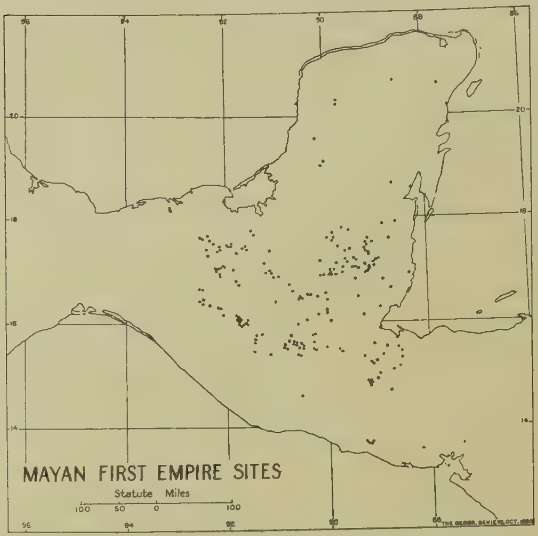

FIG. 3—Map showing sites of ruins of the First Mayan Empire. Scale, 1:16,000,000.

I have elsewhere presented the theory that American agriculture was distributed on two distinct planes corresponding to economic development, first, of the arid lands and secondly, of wet lands, both in tropical regions, and that temperate moist-land development was dependent upon the second plane of distribution.[16] In general this follows Harshberger's botanical evidence on the dissemination of maize.[17] In Mexico and Central America there is a safe priority of several thousand years for arid-land agriculture, and some of the plants domesticated under the régime of irrigation spread to the very limits of the New World agricultural area. The staple plants were modified to meet humid conditions probably under the stimulus of a pressure of population on food supply which induced farmers to invade the wet forests. On the other hand, the new plants domesticated in humid habitats had only a restricted distribution and were never developed to meet dry conditions; witness cacao, manioc, and pineapples. Perhaps the most widely distributed plants of the wet lands were sweet potatoes and peanuts, both capable of being grown in temperate regions.

It appears that the dry-land culture of Mexico and Central America, traced by the vestiges of Archaic art, spread first of all through arid lands into our southwestern states and into western and northern parts of South America. Then the adaptation to the forest zone in the Mayan area took place, and the great economic success of this led to the conquest of forest areas elsewhere in Mexico and Central America, parts of South America, and the West Indies. We know from their calendar, etc., that the Mayas were established in rainy regions as early as the seventh century before Christ. If we grant an original seed population of 8000, a peak of 8,000,000 is found after ten doublings. This is not excessive for 1200 years of undisturbed social evolution, and indeed it appears that the strongly urban conditions of the sixth century of our era demand an even greater number. From the archeological evidence the region of the First Empire appears to have been one of the most densely peopled parts of the world.

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[16] H. J. Spinden: The Origin and Distribution of Agriculture in America, *Proc. 19th Internatl. Congr. of Americanists, Held at Washington, Dec. 27–31, 1915*, Washington, 1917, pp. 269–276.

[17] J. W. Harshberger: Maize: A Botanical and Economic Study, *Contribs. from the Botan. Laboratory of the Univ. of Pennsylvania*, Vol. 1, No. 2, Philadelphia, 1893.

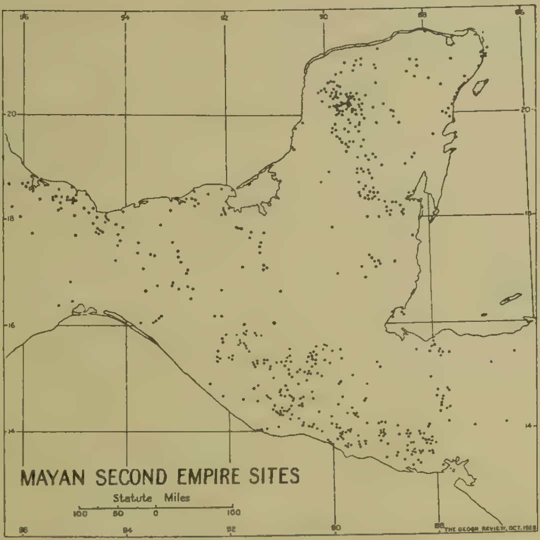

FIG. 4—Map showing sites of ruins of the Second Mayan Empire with the high development in northern Yucatan.

THE TOLTEC PEAK

The Mayan First Empire suddenly crumbled; and, considering the involved urban life in a far from friendly habitat we must imagine that this collapse resulted in tremendous mortality. Ranks of society were re-formed, however, and a second minor peak was reached in the much drier region of northern Yucatan about 1200 A. D., coinciding with the activities of the Toltec kings who conquered Chichen Itza in 1191 A. D. At this time on the highlands of Mexico a strong urbanization movement was taking place. It seems to have begun among peoples near the Mayas, namely the Olmeca, the Zapoteca, the Totonacs, etc., who lived in rather wet territory of southern and eastern Mexico, and among the Chorotega on the Caribbean coast lands to the south. But the Toltecs of the Valley of Mexico got the upper hand and under Huetzin, Ihuitemalli, and Quetzalcoatl formed a great empire of trade and tribute over the sedentary nations as far south as Nicaragua. The stimulus to population on the highlands of Mexico—doubtless high and fairly stable for many centuries—

came from imported food. We have seen that the Valley of Teotihuacán has a population of 8330. Gamio says as regards its ancient population:[18]

> The extension and importance of pre-Spanish settlements in this region, vestiges of which still exist, allow us to estimate their total population to have been ten or twenty times as great as the present one, and possibly even greater . . . There is no doubt that the definite downfall of the Teotihuacán civilization was the cause of numerous migrations from the valley; yet centuries later, when the region was conquered and came under the rule of the kingdom of Tezcuco, the population was still numerous, as may be gathered by the number of tributary settlements cited in history.

Many persons are familiar with the tremendous pyramids of the Sun and the Moon at Teotihuacán and the great structure called the Citadel. The volume of the pyramid of the Sun has been estimated at 1,290,000 cubic yards, and its weight at about 3,000,000 tons. But the famous pyramid of Cholula, which seems to have been constructed in a comparatively short period by disciples of Quetzalcoatl in the thirteenth century, is three times as large, with a total estimated weight of nearly 10,000,000 tons. The vast terracings of Xochicalco are scarcely less impressive evidence of human labor demanding dense population. In 1927 I explored a scantily peopled section south of the city of Vera Cruz and found tremendous earthworks of the Olmeca. Then there are Monte Alban of the Zapoteca and many other vast remains of pre-Columbian Mexico and Guatemala. The evidence indicates that population on the Toltec level (1000–1200 A. D.) was much greater than when Cortes arrived in 1519 A. D. The Toltec Empire collapsed in the second decade of the thirteenth century with civil war, starvation, and disease as the designated causes.

ANCIENT INDIAN POPULATION NORTH OF MEXICO

Estimates of the ancient Indian population for the area of the United States and Canada have not been based on archeological evidence so much as on indications during some early stage of European contact. A most complete study of this area by James Mooney has recently been published as a posthumous work.[19] The total number of Indians for America north of Mexico at the advent of the whites is here estimated at 1,150,000, divided as follows: United States 846,000; Canada 220,000; Alaska 72,000; and Greenland 10,000.

Mooney's figures seem overconservative for a large part of the United States, and yet they are lowered in detail by several writers on special fields. The densest settlement existed in California and along the Pacific coast as far north as Alaska. All the tribes of this area were on a pre-agricultural plane of life which was not widely nomadic, thanks to a fair food supply consisting of acorns, various wild root crops, and salmon. That these pre-agricultural people should have established themselves in much greater density than the central and eastern Indians of the United States who possessed agriculture seems inexplicable unless, as we surmise, the western population was near its crest when whites arrived while the central and eastern population was already depleted.

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[18] Gamio: *op. cit.*

[19] The Aboriginal Population of America North of Mexico, *Smithsonian Instn. Publ. 2955*, Washington, 1928.

Mooney's total for California is 260,000 souls, following the figures of C. Hart Merriam based on mission statistics. Kroeber[20] reduces the population of the state for the year 1770 to 133,000. Today it is only 15,000, indicating a decrease of 89 per cent from the smaller estimate. Even if we accept Kroeber's reduction the density of Indian population in California remains nearly four times that of the rest of the United States.

The non-agricultural Indians of America have had more difficulty meeting the competition of the whites than the agricultural Indians except those bearing the full brunt of early colonization. Their old food supply has been cut off, and violent readjustments in their mode of life have been accompanied by a rising death rate. Along the Pacific coast the salmon runs have been depleted by commercial fisheries; elsewhere wild game has been killed off, including the great herds of buffalo on the Plains; while on the Plateau natural gardens of camas and other edible roots have yielded to the white man's wheatfields. Besides suffering these economic losses the non-agricultural Indians in general have been more warlike, or at least more given to resisting injustice, and have invoked their own extermination. In the case of California many tribes fell under missionary control: among these the percentage of survival is very low. Indian mortality in Oregon, Washington, and Idaho has also greatly exceeded the birth rate since the advent of the whites, the population figures for 1780 being 89,300 and for 1907 only 15,431. British Columbia and southern Alaska show nearly as bad a record.

These non-agricultural western summaries will now be contrasted with eastern agricultural ones for tribes distributed in a continuous area from the Great Lakes to the Gulf of Mexico and from the Atlantic to considerably beyond the Mississippi and well up the Missouri. The purely nomadic buffalo-hunting tribes of the Great Plains are marginal and are eliminated from the tabulation as well as all Canadian tribes except the few that practiced agriculture. The dates at the left in the following table give the eras at which Mooney calculates the population.

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[20] A. L. Kroeber: Handbook of the Indians of California, *Bur. Amer. Ethnology Bull. 78*, Washington, 1925, pp. 880–891.

1600	New England, New York, New Jersey, and Pennsylvania	55,600
1600	Maryland, Delaware, the Virginias, and the Carolinas	52,200
1650	Georgia, Alabama, Tennessee, Florida, Mississippi, most of Louisiana, and part of Arkansas*	114,400
1650	Agricultural tribes of the Central States**	40,300
1696	Agricultural tribes of the Southern Plains	12,900
1780	Agricultural tribes of the Northern Plains	38,000
1600	Agricultural tribes of southern Canada	35,300
		348,700

* Swanton, who edits Mooney's work, reduces these figures by about 18,000 mostly on estimates of the Creek and Chickasaw.

** I exclude the Ojibwa as non-agricultural until recent times. Some of the other tribes are only partly agricultural.

This eastern agricultural area covers about 1,375,000 square miles of territory, and the figures of Mooney give one person to four square miles. Today this same area, resting heavily in the matter of food on Indian plants,[21] supports a population of something like 90,000,000 individuals.

The Problem of the Mounds

Now the mute evidence of the mound culture existing in the central part of this eastern agricultural area attests rather dense population over a considerable interval of time. Mooney's data show that at the epoch of white settlement Ohio[22] and West Virginia were practically deserted and that the region of the mounds had in general a scantier population than the surrounding territory. Contrary to early theory it has now been demonstrated that the mounds were built by the ancestors of existing tribes and that some of them are of no great age, since they contain objects of European manufacture. What is the answer to this riddle? I believe that the conditions can best be explained on the theory that diseases of European origin introduced by fleeing natives from the West Indies or by Spanish explorers, such as Ponce de Leon, swept up through the mound area several generations before the establishment of the English and French colonies. But the culture of the mound builders was already decadent, and its peak must doubtless be placed several centuries before Columbus.

Shetrone[23] says of ancient Ohio:

> Perhaps no equal area in the world contains so many prehistoric earthworks as the territory comprised within the state of Ohio. The . . . recently published Archeological Atlas of Ohio locates a total of 5396 prehistoric sites of the various classes. Of these, 3513 are mounds proper, 587 enclosures and fortifications,

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[21] About four-sevenths of the agricultural production of the United States (farm values) are in economic plants domesticated by the American Indian and taken over by the white man.

[22] The Erie nation had been destroyed in 1656 by the Iroquois, and after that for half a century Ohio was uninhabited.

[23] H. C. Shetrone: The Indian in Ohio, *Ohio Archaeol. and Hist. Quart.*, Vol. 27, 1918, pp. 274–510; reference on pp. 467–468.

354 village sites, 39 cemeteries, 5 effigy mounds, 17 petroglyphs or pictured rocks, and 35 rock shelters or shelter caves. Besides these, 190 flint quarries and many individual burials, some graves, and other sites are located.

Some of the mounds are of large size, and their construction represents much labor. The largest mound of all is that at Cahokia opposite St. Louis, but the De Soto mound in Arkansas and the Etawah mound in Georgia are impressive constructions. The Cahokia mound is 1080 feet long, 710 feet wide, and 100 feet high, and covers 16 acres. The volume has been calculated at 21,690,000 cubic feet. But it is only one out of many manifestations of high population in a restricted district.

In Mooney's estimate we are asked to believe that only about 150,000 Indians dwelt in the mound area at the advent of the whites. This may be true if the advent is placed at 1610 A. D. instead of 1492 A. D. Also the abundant remains have been explained by imagining a small population existing for a very long time. But evidences of art and the law of population increase do not justify such dilation. It is at least seen that the concept of mounds for temple foundations cannot live when generations after generations are called upon to build the substructure of the temple. Rather it seems that the eastern agricultural area must once have supported several millions and that a halcyon period a century or two before the arrival of Columbus was ended by war and the pressure of wild tribes.

The Case of Pecos

In the Pueblo area abundant evidence points to an ancient régime of agriculture following an introduction of maize, beans, etc. from Mexico on the culture levels known as Basket Makers II and III. Strangely enough the earliest finds come from a small region far removed from the Mexican border,[24] while on the following culture levels called Pueblo I and II the geographical expansion of small-town remains reaches its greatest extent towards the northwest. Pueblo III is the time level of large towns formed by consolidations of small ones, and there is a withdrawal from the northwest towards the south, without, however, any great change in the total area covered. In this brilliant period the population of the Southwest reached its maximum, and trade with Mexico was developed. The Pueblo outposts were then in the state of Chihuahua, and the Toltec outposts were close by in Durango. Pueblo art and ceremony gained new elements from their Mexican correspondents. This vitalizing contact doubtless ceased with the fall of the Toltec empire in 1220, and it is a remarkable fact that a collapse in the Southwest closely paralleled the collapse in Mexico. In part this must be explained by the raiding activity of nomadic tribes; but, whatever the causes, the area occupied by the village Indians shrank suddenly to about the present meager limits. There must have been a sharp decrease in numbers over the total area of the Southwest, and this decrease seems to have continued till comparatively recent times. At least many villages have been abandoned, and two languages, the Tano and Piro, have become extinct.

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[24] See, for example, A. V. Kidder: An Introduction to the Study of Southwestern Archeology, Published for the Dept. of Archaeology, Phillips Academy, Andover, Mass. *Papers of the Southwestern Expedition, No. 1*, New Haven, 1924.

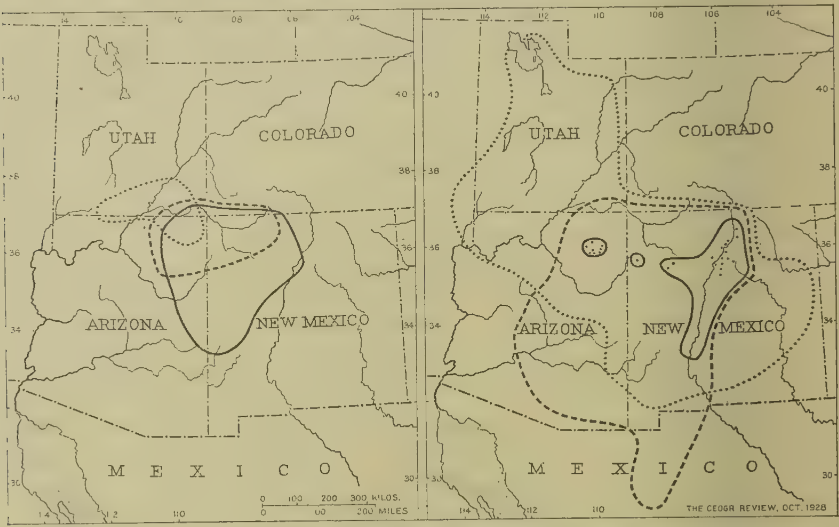

FIG. 5—Development of Pueblo culture. The left-hand map shows the nucleus of Pueblo culture: dotted line, region of Basket Maker II; dashed line, Basket Maker III; solid line, Pueblo I. The right-hand map shows the expansion and contraction of Pueblo culture: dotted line, Pueblo II; dashed line, Pueblo III; solid line, region occupied at the conquest; modern Pueblos are shown by dots.

A population curve for the pueblo of Pecos has been constructed by E. A. Hooton on the basis of burials associated with pottery, which reaches a peak at about 5000.[25] In general the results obtained are in agreement with the archeological evidence in the number of rooms occupied at different times. We seem to have here a population curve in which the rise is explained by social and economic efficiencies and the fall by decreasing agricultural returns, by disease introduced by Europeans, and lastly by savage warfare intensified after the horse had made long raids possible.

SOUTH AMERICAN ARID-LAND CIVILIZATION

In South America the agricultural civilizations are more ancient in the arid and open regions of Colombia, Ecuador, Peru, etc. than in the wet forested regions of the Guianas and Brazil; but fluctuations and displacements of population are more marked in the wet country for reasons that are not far to seek.

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[25] Manuscript on Skeletal Remains at Pecos, to be published in the same series as reference 24.

The earlier series of Central American economic plants must have reached Peru during the Archaic period a thousand years or more before the time of Christ. Under the fairly stable but inelastic conditions of desert-land farming a practical balance between population and food supply may well have been reached on the basis of these plants and maintained with little change for many centuries. One frequently hears the opinion expressed that the agricultural terraces, or *andenes*, of Peru indicate a greater population in the past than now exists. But these terraces are still used in rotation; and, while impressive monuments for conservation, they do not, in fact, retrieve much acreage.

There was on the Peruvian highlands a great use of the indigenous potato, which may have been gathered anciently as a wild root crop. It is an important question whether the Andean tuber actually antedates maize, beans, and squashes in Peruvian cultivation: probably not, however, since the shell heaps of Ancon,[26] quite outside the natural habitat of the potato, nevertheless yield evidences of sedentary agricultural life earlier than proto-Nascan remains, likewise near the coast; and these in turn antedate the classical remains at Tiahuanaco on the plateau. The use of the potato extended from Chile into western Venezuela along the Andean ridges.

In spite of various shiftings in the centers of empire[27] the population of Peru seems to have maintained itself without cataclysmic breaks before the coming of the Spaniards. There were, to be sure, certain peaks of artistry which may or may not correspond to peaks of population. It is my opinion that extensions of civilizing influences from Central into South America will be found to correspond roughly with the Maya and Toltec culture crests, i. e. 400–600 A. D. and 1000–1200 A. D. The evidence of these streams of influence is seen more clearly in the wet-land cultures than the dry but may be noted in the art of Chavin and Recuay and more fully still at Puruhá in Ecuador.[28]

There is no reason to believe that the rapid growth of Inca power entailed great wastage of life. Indeed, the improved economic condition which followed the building of roads and the opening up of new provinces may actually have brought about an increase in numbers, at least making it easier to relieve famines. One thing is evident enough: the Peruvian conquests were made in regions where sedentary agricultural life had long since been established. Archeological stratifications in Ecuador[29] on the one hand and in Argentina[30] on the other prove this.

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[26] Max Uhle: Die Muschelhügel von Ancon, Peru, *Proc. 18th Internatl. Congr. of Americanists Held at London, 1912*, London, 1913, pp. 22–45.

[27] See for instance P. A. Means: An Outline of the Culture-Sequence in the Andean Area, *Proc. 19th Internatl. Congr. of Americanists Held at Washington, Dec. 27–31, 1915*, Washington, 1917, pp. 236–252.

J. C. Tello: Introducción a la historia antigua del Peru, Lima, 1922 and various papers in *Inca*, Lima, 1923—.

Stratigraphic and stylistic studies are among papers by A. L. Kroeber, W. D. Strong, Max Uhle, and A. H. Gayton in *Univ. of California Publs. in Amer. Archaeol. and Ethnol.*, Vol. 21, Nos. 1–8, 1924–1927, and see also the paper on The Uhle Pottery Collection from Nasca by A. H. Gayton and A. L. Kroeber, *ibid.*, Vol. 24, No. 1, 1927.

[28] Jacinto Jijón y Caamaño: Puruhá, *Bol. Acad. Nacl. de Hist.* Quito, Vol. 3, 1922, and succeeding volumes.

Perhaps density of population in the region covered by the Peruvian empire reached its apogee under Huayna Capac, the eleventh Inca (1470–1525). But the arrival of Pizarro in 1532, in conjunction with the fratricidal triumph of Atahualpa, was a stroke of doom. There was surely a tremendous falling off among the Indians of Peru after the Spanish occupation—the dire result of repressive measures, slavery, starvation, and disease. The adjudication of numbers for an era of 1525, when the eleventh Inca died without knowledge of the coming collapse of his great empire, cannot be made now; but it is not impossible that in many regions of Peru, Bolivia, and Ecuador the Indian has about retrieved his former situation as regards numbers.

South American Centers of Wet-Land Culture

These general observations on the stability of arid-land civilizations do not hold true of certain rather brilliant but restricted cultures of Colombia and Ecuador which flourished in humid lands and which had pretty clearly fallen into decay before the arrival of European marauders; nor do they hold true of ancient centers of wet-land civilization in Venezuela and Brazil, located farther to the east. In Colombia and Ecuador I refer more especially to the Zenu, who occupied territory east of the Gulf of Uruba; to the Quimbaya[31], who held the middle valley of the Cauca; to the nameless people who built the stone monuments of San Augustin[32] on the headwaters of the Magdalena; and to other tribes, whose very designations are doubtful but who once ruled the Pacific coast of Colombia and Ecuador from Choco to Manta. An outlying contemporary center was that of the Tairona on the flanks of the Santa Marta Mountains in eastern Colombia, recently described by Mason.[33]

These form an interesting chain of localities where the humid tropics were temporarily conquered after the manner of the Mayas. The economic and social interrelations of these localities are found on the historical levels of Mayan and especially Chorotegan developments, or safely within the Christian era. The special contribution of these South American states was in metal working according to a technique which was afterwards imitated in Mexico: namely, a kind of filigree jewelry made by the lost wax process. Since no examples of this jewelry or any other objects of metal occur at the First Empire site of the Mayas while numerous specimens, some being clearly of Colombian manufacture, are found in northern Yucatan in deposits of about 1200 A. D., the conclusion is that the characteristic art of the southern centers flourished broadly from 500 to 1300 A. D. with activity in trading during the last two or three centuries of this period.

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[29] Jijón y Caamaño, *op. cit.*

[30] Éric Boman: Los ensayos de establecer una cronología prehispánica en la región Diaguita (Repûblica Argentina), *Bol. Acad. Nacl. de Hist.*, Quito, Vol. 6, 1923, pp. 1–27.

[31] Ernesto Restrepo Tirado: Los Quimbayas, a décimo octavo Congreso Internacional de Americanistas que se reunira en Londres en Mayo de 1912, Edicion oficial, 66 pp., Bogota, 1912.

Eduard Seler: Die Quimbaya und ihre Nachbarn, *Gesammelte Ablandl.*, Berlin, Vol. 5, 1915, pp. 63–76. From *Globus*, Vol. 64, 1893, pp. 242–248.

[32] K. T. Preuss: Bericht über meine archäologischen und ethnologischen Forschungsreisen in Kolumbien, *Zeitschr. für Ethnologie*, Vol. 52–53, 1920–21, pp. 89–128. "Ausgrabungen in der Gegend von San Agustin" covers pp. 91–105.

Idem: Die Ausstrahlungen der San Agustin-Kultur in Amerika, *Zeitschr. für Ethnologie*, Vol. 59, 1927, pp. 111–112.

[33] J. Alden Mason: Archeological Researches in the Region of Santa Marta, Colombia, *Compte-Rendu Congrès Internatl. des Américanistes, 21st Session, 2nd Part, at Göteborg, 1924*, Göteborg Museum, 1925, pp. 159–166.

In addition to metal work there are other important intercontinental changes in technology and design, regarding which space does not permit elaboration. But the important bearing of these archeological indications is on the question of ancient population of the wet tropics below the intensively developed Mayan territory. For, if civilization had a long time to run in such environment, it must surely have resulted in dense settlements.

The best evidence that civilization did have a fairly long life in certain parts of humid South America is seen from the fact that a high culture existed about the mouth of the Amazon which had disappeared before the arrival of the whites. The archeological bond between Central America, Venezuela, and the lower Amazonas is first found on the Archaic level corresponding to an early distribution of the maize complex.[34] But eastern Brazil became the center of new agricultural developments. Manioc, sweet potatoes, pineapples, etc. seem to have been domesticated here and distributed towards the west. The high culture attributed to the Arawack and Tupi tribes was broken down by the raiding Caribs, and the beginning of the West Indian occupation may correspond roughly with the end of the Amazonian civilization. Some of the tribes moved out over the Antilles, and others pushed down along the coast of Brazil. But there are other evidences that the Amazonian use of jade and several religious concepts displayed in art must be placed at the earliest about 1000 A. D. This leaves, however, a long enough interval after the introduction of agriculture on the Archaic horizon to account for high populations.

Conclusions

1. The present equivalent of the Indian blood in the New World is in excess of 25,000,000 individuals.

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[34] Female fetishes of fertility reach from Mexico to the island of Marajo in the mouth of the Amazon. For a brief presentation of the evidence see my "Ancient Civilizations of Mexico and Central America," published as a handbook by the American Museum of Natural History, 3rd edition, 1928.

2. There are fewer Indians today than at the coming of Europeans.

3. Various ancient peaks are indicated by the archeological record in different parts of the New World. The first high population level was reached in Central America and Mexico during the First Empire of the Mayas (with greatest density about 550 A. D.), and a second one of much greater extent obtained during the florescence of the Toltecs.

4. The chronological evidence indicates the greatest aboriginal population of America about 1200 A. D., this being a halcyon epoch of far-flung trade at the maximum expansion of wet-land cultures. The numbers of the red race may then have amounted to two or three times the present numbers, or say 50,000,000 to 75,000,000 souls.

5. Fluctuations have been much more evident in humid lands, tropical or temperate, than in arid lands.

6. The greatest factor in depopulation has been disease in epidemic form.

NOTE ON THE RAINFALL MAP

In compiling this map use has been made of official statistics where available (including the U. S. Weather Bureau's West Indian and Caribbean Service, Oliver L. Fassig in charge) and standard references such as Hann's "Handbuch der Klimatologie" and Supan's "Die Verteilung des Niederschlags," *Petermanns Mitt. Ergänzungsheft no. 124*, 1898. Also of the following:

Alfred Merz: Beiträge zur Klimatologie und Hydrographie Mittelamerikas, Leipzig, 1907.

M. W. Harrington: Central American Rainfall, *Bull. Philos. Soc. of Washington*, Vol. 13, 1895–1899, Washington, 1900, pp. 1–30.

W. W. Reed: Climatological Data for Central America, *Monthly Weather Rev.*, Vol. 51, 1923, pp. 133–141, Washington, D. C.

Paul Heidke: Regenmessungen aus Guatemala, *Deutsche Übersee. Meteorol. Beobachtungen*, No. 23, 1922, pp. A 26–30, Deutsche Seewarte, Hamburg.

Karl Sapper: Grundzüge der physikalischen Geographie von Guatemala, *Petermanns Mitt. Ergänzungsheft No. 113*, 1894.

Karl Sapper: Verteilungen des Regenfalls in nördlichen Mittelamerika (map). *Petermanns Mitt.*, Vol. 43, 1897, Pl. 10.

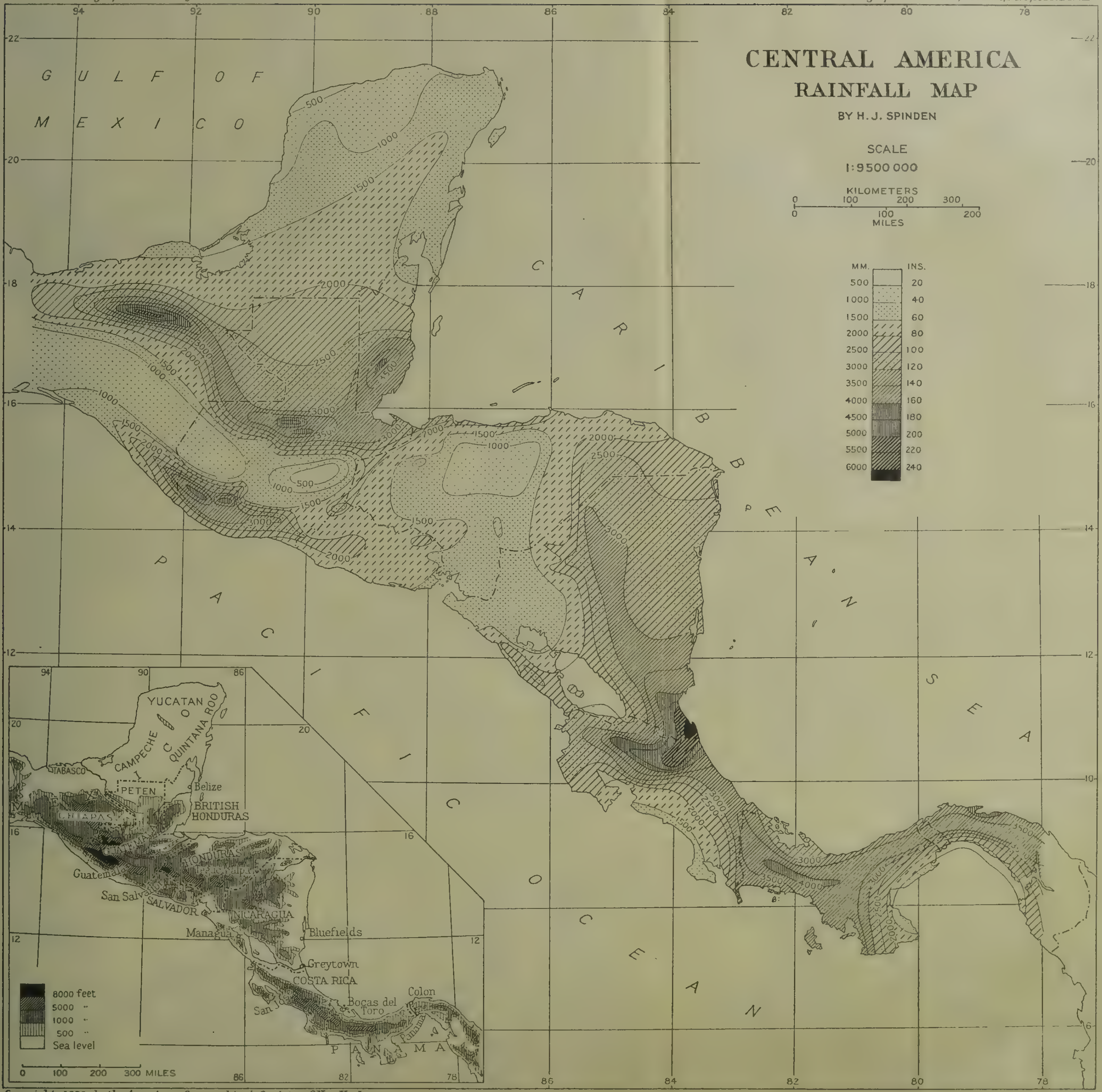
Karl Sapper: Die Alta Verapaz (Guatemala), *Mitt. Geogr. Gesell. in Hamburg*, Vol. 17, 1901, pp. 78–214.

Eckhard Lottermoser: Die Ergebnisse der Temperatur-Beobachtungen in Salvador und Süd-Guatemala, *Mitt. Geogr. Gesell. in Hamburg*, Vol. 24, 1909, pp. 31–84.

Eckhard Lottermoser: Die Regenverhältnisse Mittelamerikas mit besonderer Berücksichtigung von Salvador und Süd-Guatemala, Inang. Diss., Tübingen, 1911.

A. P. Davis: Hydrography of Nicaragua. *Twentieth Ann. Rept. U. S. Geol. Survey*, 1898–99, Part IV, Hydrography, Washington, 1900, pp. 563–637.

Rainfall records kept by commercial corporations and private individuals, mostly unpublished, including: records from the United Fruit Co. (Tela Railroad, Truxillo Railroad, etc.) in Guatemala, Honduras, Costa Rica, and Panama; the Cuyamel Fruit Co. (Cortes Development Co., etc.) in Honduras and Nicaragua; Vaccaro Brothers (Suiza Planting Co., etc.) in Honduras; Schlubach, Sapper & Co., Guatemala; Spencer Richardson, Las Cañas, Matagalpa, Nicaragua; from stations on the Salvador Railway Co.; from mines of Charles Butters, Salvador, Honduras, Nicaragua; and Minor C. Keith, Guatemala and Costa Rica, etc.



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THE INTERNATIONAL GEOGRAPHICAL CONGRESS

A REPORT upon the twelfth International Geographical Congress, held at London (July 14–17) and Cambridge (July 18–25) under the authority of the International Geographical Union, properly begins with an acknowledgment of British hospitality. The delegates and members to the number of several hundred (over 500 registered) were received and entertained in a spirit which greatly promoted the friendly interchanges that are among the best features of international assemblies. In addition to delegates from the 19 countries that have adhered to the Union there were present representatives of at least 12 other countries. If the absence of German, Hungarian, and Austrian delegates was remarked it was always accompanied by expressions of good will, admirably set in relief toward the close, by the reference of Sir Austen Chamberlain to "the welcome that is waiting for them." It was because of similar assurances from French representatives in 1927, following direct overtures at Berlin, that local American opposition to or at least apathy toward the International Geographical Union disappeared. Official relations were established early in 1928, and eight accredited delegates for the United States (*Science*, No. 1746, Vol. 67, 1928, June 15, p. 604) were sent to the Congress. In addition there was formed in the United States by the National Research Council a National Committee representing the principal geographical organizations. It will be the duty of this Committee to coöperate with the Executive Committee of the Union in carrying out the work of the latter: promoting exchanges of information, assisting in the work of the various commissions engaged in the study of specific geographical problems, and planning American participation in the next International Geographical Congress to be held at Paris in 1931.

The British National Committee did not merely welcome and entertain. It arranged a series of excursions, carefully selected, timed, and carried through. And it made a permanent contribution of the first order in the shape of a regional geography entitled "Great Britain,"[1] a copy of which was presented to each member. The volume has the great advantage of presenting the many different styles, methods, and points of view of the twenty-six British geographers who contributed sections of the text. One is tempted to quote extensively from it, so excellent is some of the material found in every paper. It is perhaps sufficient to say that it is now the standard reference on the subject and will attract the interest of every geographer not only for its material but for the methods of what may be called the British school. The effect upon the Congress of so serious a contribution should not be overlooked by those committees that have the responsibility of arranging future programs. Equally noteworthy in their effects were the printed reports of the various commissions recommended by the last Congress and advanced by the Union during the past three years. Included in the list of available publications was an excellent map (in three colors; 12 inches to 1 mile) of part of the town of Cambridge, specially prepared by H. M. Ordnance Survey.

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[1] Great Britain: Essays in Regional Geography by Twenty-Six Authors with an Introduction by Sir E. J. Russell. Edited by Alan G. Ogilvie. Cambridge, The University Press, 1928.

Geographical Congresses: History and Purpose

An international congress seems to have three principal results: the bonds of friendship are strengthened amongst members of a profession, there is a volume of "proceedings," and provision is made for the continuation through "commissions" of research enterprises that require international coöperation.[2] It is doubtful if the International Millionth Map of the World (Carte du Monde au Millionième) would have been initiated, and it would most certainly not have fared so well, if it had not come repeatedly before geographical congresses since its first proposal by Professor Penck at the Congress of Berne in 1891. The commission form of organization for continuing work gives direction to research and thus provides for that concentration upon limited objectives which is generally lacking in the several section meetings. It would be contrary to the spirit of an international congress to exclude weak papers. Every one must be heard. The most diverse points of view are presented often with no real opportunity for discussion. Groups of quite disconnected papers may be given. The result would be confusing if it were not for the commissions which focus the work of groups with like interests and supply related papers in at least some of the sections. The growth of the work of the commissions seems likely to make the congresses of the future increasingly valuable.

The development of geographical congresses is summarized in a timely review by Sir Charles Close, published in pamphlet form for distribution at Cambridge.[3] Every geographer should obtain a copy of this interesting address delivered at the Anniversary General Meeting of the Royal Geographical Society in June, 1928. It contains an invaluable account of the history of international geographical congresses from the first one held at Antwerp in 1871 down to the one held at Cairo in 1925. Here will be found a summary of the most important resolutions passed, ideas presented, personalities engaged, and the character of the communications. The conclusion offers a point of view as to the content of geography.

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[2] Reference should here be made to the report by Professor Baulig of the International Geographical Congress held at Cairo in 1925 (*Geogr. Rev.*, Vol. 15, 1925, pp. 470–474).

[3] Colonel Sir Charles Close: International Geographical Congresses: A Brief Account of Their Origin, History, and Proceedings, Royal Geographical Society, London, 1928. It appears in the August number of the *Geographical Journal.*

Reports of Commissions

Because the programs of past geographical congresses have dealt predominantly with physical and mathematical geography it was gratifying to see a substantial monograph and sectional papers on an important phase of human geography—the rural habitat. Besides the scholarly and thought-provoking preface by Professor Fleure and the monographic treatment of all aspects of the question by Professor Demangeon in the longest chapter in the report (La géographie de l'habitat rural) there are intensive studies of specific regions: Rural Settlements in South-West Wales (Bowen), The Village Community of Alderney (Harris), and similar studies by Sayce, Leeds, King, and Grant. Clearly the European studies of rural groupings, with their necessary emphasis on the historical evolution of types of cultivation, are of a character quite different from those that have been pursued in the New World. The agricultural development of America has had definite stages and changes, but these reflect economic conditions rather than the broad social effects such as accompany political and racial revolutions. Mexico is perhaps the sole exception.[4]

Professor E. de Martonne, in Publication No. 3 of the International Geographical Union, "L'extension des regions privées d'écoulement vers l'océan" (collaboration of L. Aufrère) has brought to a conclusion a work upon which he has been engaged for some years. A first report at Cairo in 1925 was followed by a paper and map in the *Geographical Review* in 1927; and the map, subsequently republished in the *Annales de Géographie*, now reappears in the definitive report. A fully documented description is given of the method and its detailed application, region by region. Thus geography has contributed to geology, to plant and animal ecology, and to history as well, a critical statement as to interior-basin drainages and related climates over the world as a whole and from the best descriptions and cartographic sources.

Under the presidency of Sr. Hernández-Pacheco of Madrid there was brought out in preliminary form a "Report of the Commission on Miocene and Pleistocene Terraces" (International Geographical Union, Publication No. 2). It consists of nineteen papers dealing with coastal terraces and beaches, fluvial terraces in relation with the coast, changes of climate and in the level of the land. Most of the papers deal with Mediterranean shores and drainages; one group with the British Isles, and a few Asian and more distant African examples. The report consists of related papers, but no general conclusions are drawn. Hernández-Pacheco and others summarize the river-terrace conditions of Spain, and Wright the raised beaches of the British Isles. But much further regional work is required before a larger synthesis can be attempted.

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[4] See G. M. McBride: Land Systems of Mexico, *Amer. Geogr. Soc. Research Ser. No. 12*, 1923.

The Papers Read

It would require too much space to make suitable reference to each paper in the program. For the titles of papers, the organization of the Congress, the personnel of committees, the receptions, map exhibitions, special lectures, excursions, and abstracts of papers, reference should be made to the "Handbook for the International Geographical Congress" (with additions and corrections). The Congress was divided into six sections—Mathematical, Physical, Biological, Human, Historical, and Regional; and these met simultaneously between 10.00 and 12.30 a. m., the afternoon being given to excursions and general lectures. Without discriminating between a large number of interesting papers and excursions, special mention may be made of a few by way of illustrating the range and character of the program. The Dean of Norwich (Dr. Cranage) gave an extraordinarily interesting historical account of "Cambridge: The Town and University," especially valuable for those foreign members who were visiting for the first time an old English university town. The classic query—What is geography?—had a new and stimulating answer in "The Content of Philosophical Geography" by Sir Halford Mackinder. Professor Almagià presented his nearly complete "Monumenta cartographica Italiae," a collection of 65 reproductions of early maps and 55 pages of text. H. R. H. the Duke of Apulia gave an illustrated general lecture on his recent explorations in "The Tripolitanian Sahara." The brilliant archeological results obtained by aerial photography in southern England were presented by Mr. O. G. S. Crawford.[5] A group of distinguished papers on Egypt was an interesting feature of the program. Besides Hussein Sirry Bey's papers on the cartography of Egypt, and a physiographic paper by Dr. Hume, there were addresses by Desio (Giarabub Oasis), Awad (Evolution of the Nile), Hug and Lozach (The Rural Habitat), Selim (Trade in the Middle Ages), and Amer (strikingly rapid population growth as affected by the change from the basin system to the perennial system of irrigation). Dr. Uchida's analysis of cultivated land in Japan presents an analogous study of dense population: fifteen per cent of the land supports half the families, and rice culture

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[5] See O. G. S. Crawford: Air Survey and Archaeology, *Ordnance Survey Professional Papers No. 7* (N. S.), Southampton, 1924.

(supporting the highest densities) compels the use of land of limited selection, while a paper on the population of Denmark, by Professor Vahl, explained how the densities vary in response to the contrasts in practices upon large estates and small holdings and forests and open country even where there are no differences in fertility. A notable series of papers (based largely upon the work of the corresponding commission) related to the rural habitat in Italy, Egypt, Yugoslavia, Czechoslovakia, France, and England. Special mention may be made of Mlle. Lefèvre's paper on a general classification of types of habitat.[6] Another group dealt with climatic variations (Gregory), the climate of prehistoric Greece (Myres), of England in the seventeenth century (Baker), of Poland from the fifteenth to the seventeenth century (Polacsch), and of southeastern France (Bénévent). Professor De Marchi proposed a commission on climatic variation.

Physiographic papers concerning such diverse themes as interior-basin drainage, coastal evolution, speleology, loess, and crustal dislocation were presented by Romer, Johnson, Calciati, Atwood, Barbour, Yamasaki, and Imamura. Professor Romer strongly challenged de Martonne's method of determining the units of interior-basin drainage and outlined new principles to guide further investigation. Dr. Barbour shed new light on the origin of loess in a period when man was driven out of western-central China by the severity of the climate, to return again by way of the broad valleys. A group of printed papers dealing with the scientific exploration of the Red Sea was presented by Captain Mancini, director of the Royal Italian Hydrographic Institute. Dr. Negri presented the studies of the Italian National Committee on the plant and animal life of high mountains. De Filippi described his Central Asian Expedition of 1913–1914; and Sir Francis Younghusband gave an account of the Shaksgam Valley. Papers by Deherain, Fordham, Stevenson, Castro, Myres, and Mackinder ably represented the field of historical geography and discussed the geography of Ptolemy, the history of exploration, the historical geography of England, and early Spanish mapping in the New World. Atlases, surveys, projections, geodesy, and cartography were the subject of papers by Sir Charles Close and Hussein Sirry Bey (New Atlas of Egypt), Hinks, Romer, Werenskiold, de Lavalette, Reeves, Jones, and Bognetti (International Atlas of the Italian Touring Club with sources and text in Italian, French, German, Spanish, and English). Equally valuable were the many other papers in other fields of geographical research such as economic geography including transportation, educational geography, aerial photography, and city geography.

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[6] See also Marguerite Lefèvre's "L'habitat rural en Belgique: Étude de géographie humaine," Bibliothèque du Séminaire de Géographie de l'Université de Louvain, H. Vaillant-Carmanne, Liége, 1926.

EXCURSIONS AND SOCIAL EVENTS

Among the several excursions to near-by localities special mention may be made of one only: Wicken Fen. An excellent paper on the Fenlands by Professor Frank Debenham, of the Department of Geography at Cambridge, is published as one of the regional studies in "Great Britain," the volume noted above. There was also made available an interesting pamphlet by Professor G. Stanley Gardiner published on behalf of the Local Committee of the "National Trust for Places of Historic Interest or of Natural Beauty." With these documents and under the leadership of Professor Gardiner a party was able most profitably to visit and understand the evolution of the fen country. Ely Cathedral, whose history is closely connected with that of the original waterways and marshes of the neighborhood was visited en route. Of the post-Congress excursions mention may be made of a tour to Wales under the direction of Professor Fleure to study "The physical features of Wales, the Snowdon Range and its dissection, the great estuaries,—the coal valleys, the Wye Valley and its incised meanders—[and] the natural regions of Wales from the human point of view."

The President and Council of the Royal Geographical Society of London received the members of the Congress on July 14. The Science Museum at South Kensington invited members to inspect its geographical, meteorological, geodetic, and astronomical collections. The Lord Mayor of London and the Corporation of the City of London arranged a Reception and Conversazione at the Guildhall which was honored by the presence of H. R. H. the Prince of Wales. Addresses by the Vice-Chancellor of the University of Cambridge and by General Vacchelli, President of the Union and the Congress, opened the program at Cambridge. At a later session the Vice-Chancellor conferred honorary degrees upon General Vacchelli, Colonel Sir Charles Close, and Professor de Martonne in the presence of a distinguished gathering in the historic Senate House. The climax of the social chapter of the Congress was the complimentary dinner to the delegates by H. M. Government in Trinity College where Sir Austen Chamberlain, Secretary of State for Foreign Affairs, presided, afterwards receiving the guests in St. John's College. Special mention should be made of the hospitality of the Masters of colleges who arranged receptions or entertained guests: the Masters of Pembroke, Gonville and Caius, Emmanuel, Jesus, St. John's, Trinity, Sidney Sussex, Christ's, St. Catherine's, and Magdalene. The Principal of Newnham and the Mistress of Girton invited members to tea, and Dr. Alan Gray of Trinity College Chapel gave an organ recital.

The Captain Scott Polar Research Institute received a limited number of members of the Congress; and, on behalf of the Managing

Committee, Dr. Hugh Robert Mill described the objects of the Institute, its collections, its future possibilities.

The International Map of the World

There remains to mention the work of the Commission on the Millionth Map of the World. The meeting, held at the house of the Royal Geographical Society, was attended by official representatives of about twenty nations. Agreement was quickly reached upon a number of additions and changes in the conventional sign sheet. A less cumbersome group of symbols for international boundaries was adopted, and likewise new signs for wireless telegraph stations, oil wells, tunnels, railway stations, aerodromes with hangars, landing grounds for airplanes, airship stations. The relative reliability diagram, a feature of the sheets of Hispanic America published by the American Geographical Society, is now made a requirement for standard sheets. It is proposed hereafter to publish two key maps for sheets issued: one for standard sheets from whatever source derived, whether official or unofficial, and a second for sheets that do not conform to the standard requirements. It may be noted here that the International Geographical Union approved Mr. Crawford's proposal to publish in a special edition those sheets of the Millionth Map that included the territory of the Roman Empire at its greatest extent, with a special symbolism for features of historical, archeological, and geographical interest.

At the final plenary session of the Congress General R. Bourgeois was elected President of the Union, General Vacchelli First Vice-President, and Dr. Filippo De Filippi Secretary-General. An Executive Committee of eight, including the above, acts during the ensuing three years as a continuing body charged with the organization of the next congress at Paris in 1931.

THE CENTENNIAL CELEBRATION OF THE GESELLSCHAFT FÜR ERDKUNDE ZU BERLIN

The following report on the centennial celebration of the Gesellschaft für Erdkunde zu Berlin is made by Mr. J. A. Morrison, of the University of Chicago, acting as representative of the American Geographical Society.

Towards the end of May the world's second oldest geographical society and the oldest geographical society in Germany celebrated its 100th anniversary. The occasion was signalized by inviting the various German and foreign sister societies to send delegates to take part in the commemorative exercises and to attend the Oceanographic Conference held in conjunction.

The Gesellschaft für Erdkunde hospitably welcomed the many delegates with a luncheon given in its rooms at 23 Wilhelmstrasse. After the luncheon Sir Douglas Mawson, of the University of Adelaide, South Australia, gave an extremely interesting and strikingly illustrated lecture on the Australian Antarctic Expedition, of which he was the leader.

The formal opening of the centennial celebrations was signalized by a Festsitzung held in the Plenarsitzungsaal of the Reichstag on Thursday evening, May 24, when every seat in that historic chamber was occupied. The President of the Gesellschaft für Erdkunde, Dr. Albrecht Penck, opened the session with an address and speech of welcome to the visiting delegates. In his address, Dr. Penck traced the historical development of the Gesellschaft from the time when it was only a small group of congenial students of natural science under the inspiration of Alexander von Humboldt and Karl Ritter through the von Richthofen period, when its connection with exploration was made famous by the work of German explorers in Africa and China, down to the present time. In closing, Dr. Penck urged that, the outlines of the earth now being known, the task before geographers the world over is to bring their training and knowledge to bear on the problems of population. The international note thus struck continued throughout the entire proceedings.

After the reading of greetings from the President and Chancellor of the German Republic, the representative of the world's oldest geographical society, Charles de La Roncière, vice-president of the Société Géographique de Paris, read an address in French, in which he extolled the work of German geographers and explorers. After conveying the formal greetings of his society, he presented its medal to the Gesellschaft für Erdkunde. Following him came Sir Maurice de Bunsen, representing the third oldest geographical society in the world, the Royal Geographical Society of London. Then Professor Maull spoke for the second oldest geographical society in Germany, the Verein für Geographie und Statistik of Frankfurt am Main. He was followed by Commander Luymes of the Hydrographic Bureau of the Royal Dutch Navy, who especially commended the work of German hydrographers, Professor Otto Pettersson of the Swedish Hydrographic-Biological Commission, who spoke for the several Scandinavian societies and institutes represented, Professor Everardo Backheuser for the Instituto Historico e Geographico Brasileiro and the Academia Brasileira de Sciencias, Rio de Janeiro, Professor Dr. Pompeckij of the University of Berlin for the Berlin Hochschulen and Academy of Science, Minister of State von Sydow for the German and Austrian Alpine Clubs, Minister of State Dr. F. Schmidt-Ott for the Notgemeinschaft der deutschen Wissenschaft, Minister of State Dominik for the Deutsche Seewarte, and Professor Defant of the University of Berlin for the Institut für Meereskunde.

The remainder of the evening was devoted to the presentation of medals and honorary and corresponding memberships in the Gesellschaft für Erdkunde by Dr. Penck. The Karl Ritter Gold Medal was awarded to Alfred Merz in memoriam for his untiring efforts in organizing the German Atlantic Expedition. The Karl Ritter Gold Medal was also presented to Professor Alfred Hettner for his great service to the methodical development of geography. Nachtigall Gold Medals were bestowed on Professor Karl Sapper of Würzberg for his researches in Central America and on Sir Douglas Mawson for his contribution to our knowledge of Antarctica. Nachtigall Silver Medals were presented to Captain F. Spiess and Dr. Georg Wüst for the thorough manner in which they carried out Merz's great plans for oceanographic research with the *Meteor*, to Lauge Koch (Copenhagen) for his exploration in Greenland, to Captain George Wilkins for his flight over the North Pole (presented to Captain Wilkins in person upon his arrival in Berlin), to the oceanographer Dr. Harald U. Sverdrup (Bergen) for research in the Arctic, to Dr. Björn Helland-Hansen, Director of the Geofysiske Institut, Bergen, for his oceanographic research in the northern Atlantic and the European sector of the Arctic, to Dr. Ernst Nowack (Vienna) for his work on the geology of Albania, to Dr. Anatole von Reinhardt (Leningrad) for glacial research in the Caucasus, and to Hermann Lautenbach for his service in raising the quality of geographic instruction in Germany. Several honorary and corresponding memberships in the Gesellschaft für Erdkunde were also awarded.

The Oceanographic Conference was opened by its chairman, Minister of State Dr. Schmidt-Ott, on Friday morning, May 25, in the main auditorium of the Langenbeck-Virchow Haus. Dr. Schmidt-Ott paid tribute to the work of earlier oceanographic expeditions, especially that of the *Challenger*, and eulogized the splendid results of the *Meteor* expedition.

Professor A. Defant, of Berlin University, read the first paper, "The Systematic Exploration of the Oceans." The international spirit of the conference was emphasized in his plea for international coöperation in solving the remaining problems of oceanography. The distinguished chemist, Professor Dr. Fritz Haber, in a paper on "Gold in the Sea," then proceeded in a semi-humorous vein to put a quietus on the recurrent belief that the water of the oceans contains untold amounts of gold in solution. The last paper of the morning session, "Marine Exploration with Small Vessels," was by Professor Björn Helland-Hansen. He demonstrated the value of the small ship with a limited radius of action for oceanographic exploration in the narrow seas and in the coastal waters of the oceans. As a demonstration of the interest of the German Government in the centennial celebration and the Oceanographic Conference, a luncheon was tendered the foreign delegates by the Ministry for Foreign Affairs at 8 Wilhelmplatz.

At the afternoon session of the Oceanographic Conference two papers carried over from the general session were read: the first by Dr. Johan Hjort of the Norske Geografiske Selskab, Oslo, on "The Program of International Marine Exploration," the second on "The Proposed Netherlands Expedition" to the waters of Insulinde by the Director of the Koninklijk Nederlandsch Meteorologisch Institut, P. M. van Riel.

Then followed the first of a series of papers dealing with the work and results of the *Meteor* expedition, "The Oceanographic Work of the German Atlantic Expedition," by Dr. Georg Wüst, General Secretary of the Gesellschaft für Erdkunde and one of the prime movers of the expedition. "The Biological Work of the German Atlantic Expedition" was discussed by Professor Dr. E. Hentschel of Hamburg, "The Chemical Work of the German Atlantic Expedition" by Dr. H. Wattenberg of Munich.

The centennial banquet of the Gesellschaft für Erdkunde took place Friday evening, May 25, in the ball room of the new Restaurant Kroll on the Platz der Republik, with Dr. Penck presiding. Almost five hundred guests were present. The first toast was proposed by Dr. Penck to President von Hindenburg and was followed by the singing of the national anthem. The continued success and well-being of the Gesellschaft für Erdkunde during its second century and the health of its distinguished Director were proposed by Professor Dr. Eugen Oberhummer, the president of the Geographische Gesellschaft of Vienna, in the name of all the foreign delegates. After the reading of congratulatory telegrams from all parts of the world, Director Penck announced the arrival of the *Italia* at the North Pole. His proposal that a congratulatory radio message be sent to her commander was accepted with acclaim.

The third and final session of the Oceanographic Conference took place on the following morning. Continuing the series of papers dealing with the *Meteor* expedition, Professor C. W. Correns of Rostock discussed "The Mineralogical-Geological Work of the German Atlantic Expedition," and Dr. H. Maurer of Berlin "The Echo-soundings of the German Atlantic Expedition." The final paper was read by Captain Spiess, commander of the *Meteor*, on "The Expedition Ship *Meteor* and Its Tasks." In closing the Conference, Dr. Schmidt-Ott thanked the speakers for their interesting and illuminating contributions and expressed the hope that the intensive exploration of the sea carried out by the *Meteor* expedition would be continued by other nations working under a common plan.

As a happy conclusion to the combined centennial of the Gesellschaft für Erdkunde and the Oceanographic Conference, an excursion to Potsdam was generously provided on Saturday afternoon by the city of Berlin for the Gesellschaft für Erdkunde and its guests. The excursion offered a pleasant opportunity for the renewing of old acquaintances and the forming of new ones. Several of the geographers who took part in the Transcontinental Excursion held in connection with the 60th anniversary of the American Geographical Society were present and recalled with pleasure that memorable event and the contacts made at that time with American geographers.

The commemorative "Sonderband," edited by Dr. Albrecht Haushofer and with a foreword by Professor Penck, is an attractive volume of 551 pages. Gustav Hellmann narrates the history of the Society in the latter half of its existence; the history of the previous half century is told in a heretofore unpublished address by Richthofen, given on the occasion of the fiftieth anniversary in 1878. The remaining contents are well chosen to represent the broad scope of the work now being done by German geographers. Thus, without attempting to list all the papers, we may instance Penck's "Neuere Geographie"; Sapper's "Ein Beitrag zur Paläogeographie Mittelamerikas"; Troll's "Die zentralen Anden," with a diagrammatic physiographic map in color; Franz Kühn's beautifully illustrated "Typen der andinen Landschaft zwischen 35° und 36° südl. Breite"; Jäger's "Die Gewässer Afrikas," with a colored hydrographic map novel in conception; Lautensach's "Morphologische Skizze der Küsten Portugals," with colored geological map; Friederichsen's "Ostpreussen," with Sheet N. N.-34 of the International Millionth Map of the World, finely executed; Louis's "Die neue Karte von Albanien," the map another admirable piece of cartography, in color, two sheets, on the scale 1:200,000; Finsterwalder's "Neue Aufgaben der Kartographie"; Defant's "Die systematische Erforschung des Weltmeeres"; and Wüst's "Der Ursprung der atlantischen Tiefenwässer."

The collected papers of the German Atlantic Expedition, "Berichte der Deutschen Atlantischen Expedition auf *Meteor* 1925–1927," have also been issued in similar form.

GEOGRAPHICAL RECORD

NORTH AMERICA

Wheat and the Canadian Prairie Provinces. "Canada has begun to harvest a wheat crop which will be, according to the experts, the greatest in her history, and the Prairie Provinces in particular are jubilant over the outlook" . . . "to assist in taking off the phenomenal crop 10,000 men are being brought to Canada from Britain" (press report in the *New York Times* from Ottawa, August 15). The Prairie Provinces have vast deposits of coal, great stores of pulp wood and potential water power, metallic ores "not popularly associated with them," and other agricultural resources; but wheat still remains the basis of prosperity. The accompanying maps of wheat production and of land utilization, reproduced from an excellent paper by Ll. Rodwell Jones, "Some Physical Controls in the Economic Development of the Prairie Provinces" (*Geography*, Vol. 14, 1928, pp. 284–302), tell a good deal of the story into which historical and economic factors enter as well as the geographical setting.

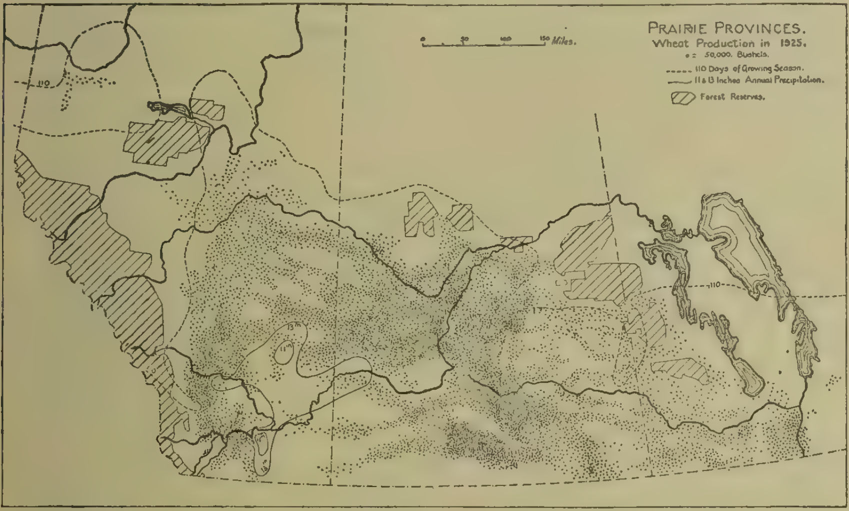
PRAIRIE PROVINCES.
Wheat Production in 1925.
● = 50,000. Bushels.
110 Days of Growing Season.
11 & 13 Inches Annual Precipitation.
Forest Reserves.
0
50
100
150 Miles.
110
13

FIG. 1—Wheat production of the Prairie Provinces of Canada, reproduced on a reduced scale from Figure 5 of Dr. Jones's paper in *Geography* (the magazine of the (British) Geographical Association). Note the minimum rainfall area of southern Alberta.

The area shown on the land utilization map as devoted to wheat is essentially coincident with the belt of natural prairie, passing on the northeastern border into the transition belt of grove land that lies between the prairie proper and the forest. The ranching area of the south is coincident with higher, drier, rougher land—the Wood, Cypress, and Milk River plateaus. Here is much abandoned farm land that should revert to ranching with supplementary winter fodder crops grown by irrigation. The belt of mixed farming bordering the wheat area is largely on grove land, or park land, as it is usually termed by the botanists (see the description of the Alberta park land in "The Vegetation of Alberta: II. The Swamp, Moor and Bog Forest Vegetation of Central Alberta," by F. J. Lewis, E. S. Dowding, and E. H. Moss, *Journ. of Ecol.*, Vol. 16, 1928, pp. 19–70), which has a slightly lower temperature and shorter growing season and greater effective precipitation. About Winnipeg longer settlement, a large urban population, and more moisture have encouraged the tendency toward mixed farming and dairying. The growth of irrigation in the southwest will also call for a greater range of rotation crops for the best use of the land.

If natural conditions have favored the growth of wheat, the demand of the European market has made its exploitation possible, and this has required efficient transportation. On the prairies railways have notably preceded settlement. Today "at least three-fourths of the true prairie territory is within 20 miles of the railway." The map of settlement now begins to show certain areas of lesser natural productivity; some so obvious that they have been avoided by the railway, some within rail reach but relatively thinly occupied. The irregularities of distribution may be studied with profit, and Dr. Jones lays a good deal of stress on the variation due to topographic irregularities. Transport remains an important question in the Prairie Provinces. Though there has been a large expansion of market westward and Vancouver is now the third wheat port of the North American continent, the Provinces are bent on the improvement of eastward facilities. Work on the Hudson Bay railway has been resumed—to a new terminal, Fort Churchill, instead of Port Nelson.

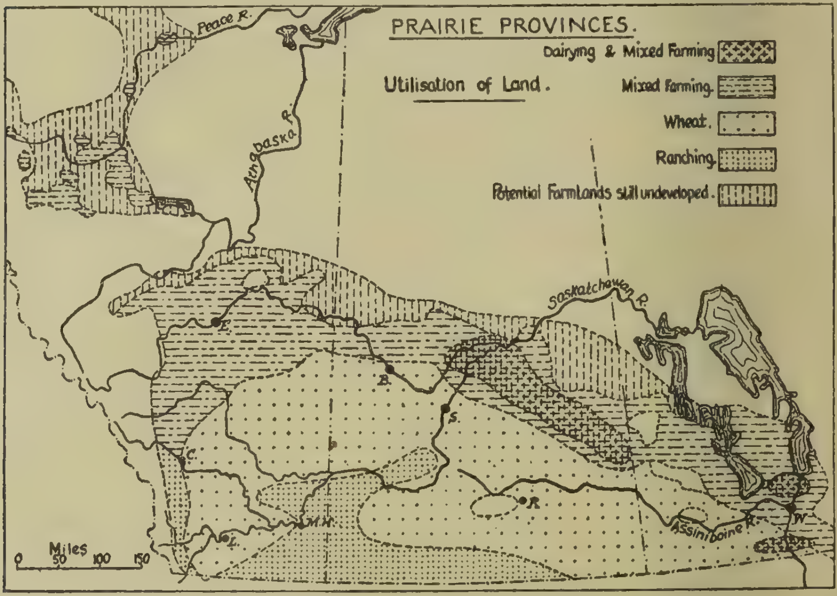

FIG. 2—Map showing use of the land in the Prairie Provinces of Canada, reproduced on a slightly reduced scale from Figure 6 of Dr. Jones's paper in *Geography*.

On the Peace River Country, not discussed by Dr. Jones, reference may be made to a recent pamphlet by F. H. Kitto published by the Department of the Interior, Canada (Ottawa, 1927). The agricultural country of the Peace River district is said to occupy an area of 73,500 square miles, considerably larger than the New England states. It has a favorable climate and fertile soil and, since the arrival of the railway from Edmonton in 1916, is rapidly growing in population. Three types of agriculture are now engaged in—straight grain growing, mainly spring wheat, mixed farming, and ranching. The "average prospective settler" is advised to turn to mixed farming, with the safety factor that it implies.

Natural Resources of the Cincinnati Region. The distribution of the mineral industries of Ohio as based on materials native to the state is depicted on a map accompanying the publication "Mineral Industries of Ohio" by J. A. Bownocker and W. Stout (*Geol. Survey of Ohio Bull. 33, 4th Ser.*, 1928). Since these industries are largely connected with oil, gas, and coal resources, a marked concentration of them occurs in the eastern and northern parts of the state. With the exception of ceramic plants and sand and gravel pits, the map shows the Cincinnati sector as notably deficient in mineral industries.

Cincinnati, on the main line of travel west from the Alleghenies, was originally a product of the Ohio River and the surrounding country, field and forest. It became a city whose activities were largely meat packing, distilling, buggy-making, and river trading. Since that time, changing conditions have largely destroyed the significance of its Ohio River location; and its new industries are not related in so simple a manner to the natural resources of the region. At present the localization of industry is many-sided—certain types of manufacturing locate at the source of raw materials, other kinds as near the market as possible or at centers of transportation or near a favorable labor supply, and still others because of some relationship to another industry. In seeking the most favorable adjustments of the activities of the city to its region and determining what kind of industrial expansion would be most suitable, the Commercial Club of Cincinnati in 1924 sponsored a resource survey by the Department of Geology and Geography of the University of Cincinnati. Most of this work consisted of selecting, organizing, and supplementing material from state and federal surveys. The result is a series of reports on the various resources and industries of the area by members of the Department of Geology and Geography, graduate students of the department, and other members of the faculty. These detailed reports have not been published, but they can be consulted in the offices of the Resource Survey. Nevin M. Fenneman has abstracted them in the *Univ. of Cincinnati, Inst. of Sci. Research* [*Publs.*], *Ser. 2, No. 1*, June, 1927.

Landslide Lakes in the Great Basin. One of the largest and most remarkable of seven landslide lakes in the northwestern part of the Great Basin, recently described by H. J. Russell, is now extinct ("Landslide Lakes of the Northwestern Great Basin," *Univ. of California Publs. in Geogr.*, Vol. 2, 1927, pp. 231–254). It occupied a 5-by-2-mile down-faulted basin in northwestern Nevada, known as High Rock Valley, which is enclosed on the east by the bold scarp of an unnamed, upfaulted, basalt-capped lava block that slants eastward under Black Rock desert; and on the west by the step-faulted slope of a slanting lava plateau, which rises for over 30 miles westward to the fault crest of the Hays Canyon Range, that overlooks the 50-mile down-faulted and aggraded trough of Surprise Valley in northeastern California, of the floor of which the same author has given a detailed description ("The Land Forms of Surprise Valley, Northwestern Great Basin," *Univ. of Calif. Publs. in Geogr.*, Vol 2, 1927, pp. 323–358). The slanting lava plateau is deeply trenched, especially by two profound canyons which drain westward into High Rock Valley; and the western unnamed fault block (illustrated by a good photograph) is cut through near its highest part by another canyon, which is taken to be the work of a stream that continued from the canyons of the slanting plateau and, under a moister climate than that of today, maintained its eastward flow, antecedent fashion, by aggrading the floor of the down-faulted basin and trenching a canyon through the upfaulted block. This canyon later became obstructed by a heavy landslide to a height of 600 feet; whereupon a lake, still recorded by high-level deltas and shore lines, rose 400 or 500 feet in the basin until it overflowed, not down the canyon obstructed by the landslide but at a sag in the fault-block crest three miles north of the obstructed canyon, and there cut down a second canyon to within 50 feet of the present basin floor. Overflow then failed, as if because of increasing aridity. The basin today, although receiving the drainage of 500 or 600 square miles, has no outlet; a wet-weather lake which sometimes overspreads its playa floor is seldom more than two or three feet deep.

A closely similar and perhaps larger landslide lake was formed near the western base of the great Warner Range fault block, at the east base of which lies the abovenamed Surprise Valley.

W. M. Davis

SOUTH AMERICA

The Historical Geography of Northwestern Argentina. A succinct account of "The Historic Geography of Tucumán" (*Univ. of California Publs. in Geography,* Vol. 2, 1928, pp. 359–386) is a recent addition by Oscar Schmieder to his several South American studies. The area dealt with, the old colonial government of Tucumán, is one of particular interest lying as it does between Andean highland and Pampean plain and influenced by both in varying degree and at various times. The south-trending structural valleys make for easy transition between mountain and plain, and here the dryness of the climate has been a most important factor. (Parenthetically it may be remarked that the use by the author of Köppen's climatic symbols without characterization is a drawback to the general reader). Agriculture, except on the eastern margins adjoining the land of the nomadic Indians, is possible only by irrigation. The area, which was strongly influenced by Peruvian culture in pre-Columbian times, seems, however, to have supported a numerous population. Archeological remains—terraced fields, dams, ditches, walls—are very numerous. Apparently its apogee had been attained before the arrival of the Spaniards (compare H. J. Spinden's paper, elsewhere in this *Review*). Some few allusions in the historical sources—and the general silence of the early writers is eloquent—also point this way. Dr. Schmieder hints at drought as a possible explanation. Commenting on Lozano's statement (Historia de la conquista del Paraguay, Rio de la Plata y Tucumán, 1745) that "a great emigration of the people of Tucumán took place into the Gran Chaco shortly before the Spaniards entered the area, a great drought with consequent famine being its cause," he says "one or several years of abnormally low rainfall, such as occur in arid regions, might easily have produced scarcity of crops, famine, and even a cultural crisis, since the warlike Indians of the plains could take advantage of the situation and invade the country."

Spanish colonization of Tucumán took place from the highlands, and the early settlements were extremely isolated. They prospered with the improvement of communications with Peru and the development of the cattle and mule trade. Not until the later nineteenth century was there any fundamental change in the character of the settlement. Then development of the Pampa as an agricultural region commenced (see Mark Jefferson: Peopling the Argentine Pampa, *Amer. Geogr. Soc. Research Ser. No. 16*, 1926. On earlier conditions see Oscar Schmieder: Alteration of the Argentine Pampa in the Colonial Period, *Univ. of Calif. Publs. in Geography*, Vol. 2, 1927, pp. 303–321; and *idem:* Die Entwicklung der Pampa als Kulturlandschaft, *Verhandl. und Wissenschaftliche Abhandl. des 22 Deutschen Geographentages zu Karlsruhe, June, 1927* (Breslau, 1928), pp. 76–86). Northwestern Argentina was drawn into its sphere of influence and turned away from the highlands. The recent completion of rail connection between Argentina and Bolivia should in some measure revive the old relation with the *altiplano*. The northwestern region retains a conscious unity. It is reflected in such a sectional development as the creation of a "Conferencia de Gobernadores" of Salta, Jujuy, Santiago del Estero, Tucumán, Catamarca, and La Rioja; the first held in 1926, a second in 1927 (see contemporary numbers of *Revista de Economía Argentina*), at which among other reforms improvement of rail communications in the northwest is strongly urged.

EUROPE

The Vegetation of European Russia. Readers unacquainted with the Russian language will be grateful to Professor Boris A. Keller of the Agricultural College, Vorónezh, for his account of the "Distribution of Vegetation on the Plains of European Russia" (*Journ. of Ecology*, Vol. 15, 1927, pp. 189–233), based on the great volume of data acquired by Russian plant geographers, soil scientists, and foresters.

He describes and gives some explanation of the well marked climatic zonal distribution of the vegetation, and a series of maps show the zones and the limits of distribution of important tree species and the chief elements governing distribution—January and July isotherms, mean annual precipitation, soils, glacial geology. Special reference may be made to the last-named. "The most important historico-geological factors are first the great glaciers which formerly covered most of the plains to be described, and secondly the waters of the Caspian Basin which at one time spread over much of the southeast." The revegetating of these areas on the retreat of ice and water may still be traced through certain elements of the vegetation. The most important are the tundra vegetation, which supposedly first occupied the ground as the ice retreated; the coniferous forest, whose development was determined by the advance of the two leading coniferous species, the Norway spruce and Scotch pine; the mid-European broad-leaved deciduous forest, which dies out from west to east and does not extend beyond the Urals; the herb and grass vegetation of the steppes, which on the contrary represents migration from east to west; the semidesert and desert flora, which has its origin in the "great mountain and desert species-forming laboratory of Turkestan."

The relations of grassland and forest are everywhere of interest. Professor Keller discusses factors hindering the spread of the Russian forest southeastward—lack of moisture in conjunction with the fine-grained steppe soil, strong steppe winds, presence of harmful salts, competition with steppe grasses, fire. "We cannot however regard the problem of the causes . . . as definitely solved," he concludes, referring to the like case of the American prairies.

Variations of the Glaciers in Western Norway. From somewhat before the year 1700 till about 1750 the glaciers in western Norway, according to old records, underwent a remarkable expansion partly or completely overriding and destroying many farms (John Rekstad: Om varias joner av isbreene på Vestlandet, *Naturen*, Vol. 52, 1928, pp. 25–31). Ice tongues extending from the large Jostedalsbreen (7° E., 61° 30′ to 61° 40′ N.) formed during their maximum stand about the year 1750 moraines that lay 1100 to 2100 meters (3600 to 6900 feet) beyond the glacier ends in 1900. The records also tell of cold and rainy summers during which the crops did not ripen and the farmers suffered famine. Such years were 1685–1687, 1695–1697, 1705–1707, 1717, 1719, and 1740–1742.

Since 1750 the glaciers have been retreating. The rate was particularly great during the latter half of the last century. The recession has not been even but was interrupted by halts and advances, known fairly well since 1850 and more accurately since 1900, when annual measurements were begun on several glaciers under the auspices of the Bergen Museum. According to measurements on 15 glaciers the average length of the cycle of oscillation is 18 years, of which 7 years are occupied by advance and 11 years by retreat. The cycle is thus one-half as long as Brückner's cycle, which averages 35 years. The glaciers began to advance in 1921 and 1922.

Ernst Antevs

Wind Deserts in Iceland. Wind erosion is by far the most important form of erosion in Iceland; and the vegetation-free areas here are not cold deserts but wind deserts, as pointed out by Carl Samuelsson (Några studier över erosions-företeelserna på Island, *Ymer*, Vol. 45, 1925, pp. 339–355) and by Niels Nielsen (Landskabet Syd-Ost for Hofsjökull i det indre Island, *Geogr. Tidsskrift*, Vol. 31, 1928, pp. 23–44). A particularly instructive case is given by Nielsen. In front of the Hofsjökull, in the heart of the island, the recent moraines carry a continuous cover of vegetation, while the older moraines farther away from the glacier practically lack vegetation and undergo wind erosion. The moisture of the ground is very great near the glacier but decreases with distance; and it is evidently the strength of the wind and the cohesion of the soil, not the temperature, that determine whether vegetation can get a foothold or not.

With decreasing moisture wind erosion reaches its greatest intensity on the plateaus of the interior, and here the most extensive deserts are to be found. Strong cold winds sweep down from the glaciers, carrying away the silt and sand and exposing and polishing cobbles, boulders, and bed rock. The material is frequently carried down to the low and narrow coast land, where it forms a loess-like deposit. Here too, where deposition is chiefly taking place, the wind may quickly carry away the precious soil and destroy farm after farm, if the turf cover gets broken.

Ernst Antevs

Fractures and Fiords in the Faeroes. The Faeroes, beautifully mapped by Danish topographers, include more than twenty islands which spread 65 miles east-west in the north and trail 110 miles to the south. They result from the dissection of an upstanding part of the vast Thulean basalt field of the northeastern Atlantic. As described by James Geikie ("On the Geology of the Faeroe Islands," *Trans. Royal Soc. of Edinburgh*, Vol. 30, 1883, pp. 217–269), who first showed that the islands had been occupied by a local system of Pleistocene glaciers, the smooth-walled and trough-like valleys and fiords, trending northwest-southeast, by which the islands are divided, as well as the hanging cirques which sometimes open in the trough walls 1000 feet or more above the fiord level, and the rock-basin lakes which frequently occupy the trough floors, "all testify to powerful glacial erosion." Grossman and Lomas ("On the Glaciation of the Faeroe Islands," *Glacialist's Mag.*, Vol. 3, 1895, pp. 1–15) emphasized the abundance of cirques in 1895 but added "we do not believe the fiords and cirques were scooped out by the ice." The archipelago has lately been visited by M. A. Peacock (Recent Lines of Fracture in the Faeroes in Relation to the Theories of Fiord Formation in Northern Basaltic Plateaux, *Trans. Geol. Soc. of Glasgow*, Vol. 18, 1926–27, pp. 1–26), who studied the relation of the fracture system, on which many deep and narrow clefts have been eroded, to the theories of fiord formation, with the result that he, like Grossman and Lomas, minimizes glacial erosion and ascribed the fiords chiefly to an advanced stage of normal erosion on an assumed system of earlier formed, northwest-southeast fractures while the region stood higher than now.

The massive form of the islands, little dissected by side valleys although steep-falling side streams abound on the fiord-trough walls, testifies strongly against this conclusion; for the normal dissection of a basalt plateau would produce islands of ragged outline, like the Pescadores, an elaborately dissected lava plateau in the China Sea next southwest of Formosa (Bundjirô Kotô: Notes on the Geology of the Dependent Isles of Taiwan, *Journ. College of Sci., Tokyo Imp. Univ.*, Vol. 13, 1900–01, pp. 1–56). The intricate embayments of the fine-textured and multibranching Pescadores valleys must of course be ascribed to submergence after advanced dissection; but the simply outlined fiords of the coarse-textured Faeroe troughs do not demand submergence; they may and probably do result simply from the invasion of the troughs by the sea as the glaciers which excavated them melted away, for heavy glaciers can erode their troughs well below sea level.

W. M. Davis

AFRICA

The Forest Vegetation of Southern Nigeria and the Gold Coast. Two excellent studies of forest vegetation in British West Africa have recently appeared as *Oxford Forestry Memoirs*, "The Physiography of Southern Nigeria and Its Effect on the Forest Flora of the Country," by J. R. Ainslie (No. 5, 1926) and "The Gold Coast Forest: A Study in Synecology," by T. F. Chipp (No. 7, 1927).

Mr. Ainslie points out that though the relief of the southern provinces of Nigeria is comparatively insignificant, it has a marked influence on the vegetation, mainly through the effect on water supply. The Niger delta directly exposed to the southwest monsoon wind of summer has as much as 126 inches annual rainfall. Inland the general rise in elevation is very gradual and rainfall steadily diminishes to 50 inches and less. Locally the influence of the northern belt of uplands, rising to 2000 feet in the highest hills, makes itself felt. In the southeast the Oban Mountains (1000 to 4000 feet) have a rainfall of over 150 inches: geographically and botanically they pertain rather to the Cameroons than Nigeria. Furthermore, they cut off the maximum rainfall effect from the Sonkwala Hills (6000 feet) to the north.

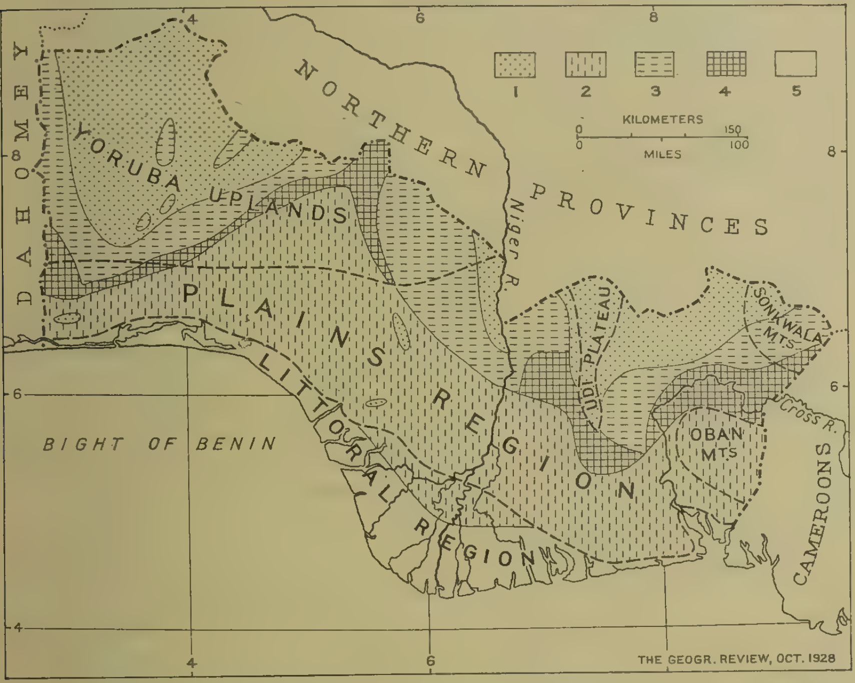

Fig. 1—Map showing the forest formations and physiographic regions of southern Nigeria, redrawn from Figures 4 and 7 of Mr. Ainslie's memoir. The numbers have reference: 1, savana; 2, tropical rain forest; 3, fringing and deciduous forest; 4, transition forest; 5, littoral forest. Scale approximately 1:7,000,000.

The littoral is characterized by mangrove forests where soil moisture is excessive and a low inferior type of evergreen forest on the sand banks. Inland lies the great belt of evergreen forest, rain forest, and, as an edaphic formation, fresh-water swamp forest. Much clearing for agriculture has taken place and as cultivation is mostly shifting large areas are covered with secondary growth, inferior and of a distinctly drier type. Such re-growth, says Mr. Ainslie, "is probably more marked in Nigeria than generally elsewhere in the tropics, partly because of the large areas involved in this forest destruction, but mainly because of the results of what has been termed 'the desiccation of Africa.' Many reasons have been propounded for this, but the most probable is that these climatic forests originated here when the climate was more moist and when the coast-line was farther north than it is now, and they are now very near their dry climatic limit."

The rain forest is generally limited by the 70-inch rainfall line; it passes gradually into a deciduous forest (about 75 per cent of the trees shed their leaves in the dry season) with fringing forest along the streams. The northern boundary of the deciduous forest, about the 50-inch rainfall line, is abrupt. The savana formation to which it gives place seems to be an artificial creation, a secondary growth replacing former woodland where repeated burnings have destroyed the original cover. Grassland at present occupies only a small area in Southern Nigeria, though it is likely to increase. It occurs on exposed heights, notably on the Udi Plateau (1200 to 2000 feet), where drainage is rapid and evaporation excessive.

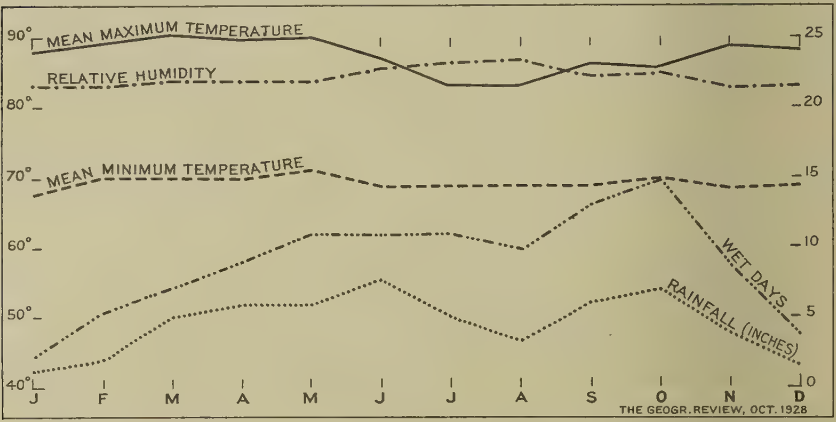

FIG. 2—Ideal climatic chart of typical closed forest region of the Gold Coast, redrawn on a different horizontal scale from Figure 19 of Mr. Chipps' memoir. Temperature scale in °F. on left; inches of rainfall and number of rainy days on right. Note the abatement of rains in August, equable temperatures, high and constant relative humidity.

Mr. Chipp, who is the author of the chapter on tropical countries in the useful handbook "Aims and Methods in the Study of Vegetation" (London, 1926), makes a special analysis of climate in relation to the Gold Coast forest and publishes a series of climatic graphs including a type graph which, drawn on a different horizontal scale, is here reproduced. The vegetation of the country is classified as closed forest and parkland (this term preferred to the rather vague "savana") with maritime vegetation as an edaphic formation.

He describes the closed forest as a product of the "Guinea" climatic belt, in the Gold Coast modified to a "distinctly anomalous type," a monsoon climate. Rainfall is greatest immediately behind the shore line trending north of west to south of east and diminishes northeastward. The southwestern aspects of the local relief lying across the track of the southwest monsoon contrast with the much drier northeastern aspects. The 2000-foot Kintampo-Ejura escarpment marks the northern limit of the forest. Parkland is the product of the "Sudanese climatic" zone. Soil here plays an important part; the predominance of sandstone and of hard laterite surfaces is associated with low ground water. In this paper parkland is considered only in its relation to the closed forest on the northern, southern, and eastern borders of which, thanks to man's intervention, parkland is encroaching.

The Economic Transformation of the Gold Coast. In "The Economic Revolution in British West Africa" (London, 1926), Mr. Allan McPhee justifies the use of the term "revolution" by the suddenness and radical nature of the changes that have taken place in this region the last forty years. In the Gold Coast this transformation has assumed a special form, the dominant cocoa industry, which even the sober Parliamentary Report describes as "little short of a romance" (Report by the Hon. W. G. A. Ormsby-Gore, M. P. (Parliamentary Under-Secretary of State for the Colonies), on his Visit to West Africa during the Year 1926, Cmd. 2744, 1926).

In 1879 a Fanti laborer succeeded in smuggling some cocoa pods from the jealously guarded plantations of Fernando Po into the Gold Coast Colony. His plantings prospered. One of the West Coast missions took up the new cultivation. Then the Government became interested. In 1891 the first shipment of 80 pounds of cocoa was made from the colony. In 1926, 231,000 tons were exported (L. J. Schwarz: Cocoa in West Africa, *U. S. Dept. of Commerce Trade Promotion Ser. No. 68*, 1928). The Gold Coast has become the major cocoa-producing country of the world. As an economic romance the industry is comparable with that of rubber or quinine in southeastern Asia and Malaysia. But, unlike the greater part of these introduced cultivations which are European-owned plantations, the cocoa cultivation of the Gold Coast is entirely in native hands. (In recent years there has been a tremendous increase in the number of native-owned rubber plantations in Java.) Native control is a policy applied not only to cocoa in the Gold Coast but to all agricultural resources in British West Africa: only minerals are being developed by the foreign capitalist. The policy is unique, and it furnishes a particularly striking contrast with conditions on the other side of the continent. Mr. McPhee suggests some of the contributing causes to this differentiation of policy: the sudden contact of European and native civilization in East Africa as compared with the old established relations in the West, the dominance of pastoral economy, and a climate better suited for the white man. The change from a "natural" to a "monetary" economy is bringing a host of other changes in its train to the natives of the Gold Coast. Land is becoming a commercial commodity, and there is a weakening of the old communalism and tribal authority.

But the success of the natives on their little cocoa farms would not have been possible without governmental aid, both as regards agricultural processes and marketing. Growth of the industry is closely related to growth of transportation facilities. The Gold Coast is naturally poorly endowed with waterways and harbors. The Report on Economic Agriculture for 1889 said "The only available beast of burden is man, the weakest and most costly of all." The country now has three railroad lines, 475 miles in all (Gold Coast, Rept. for 1926–27, *Ann. Colonial Repts. No. 1386*, 1928). Western and eastern lines converge on Kumasi from Sekondi, passing through the gold and manganese fields, and from Accra, through the main cocoa district; a central line has recently been opened. In the last seven or eight years the Government has been very active in road construction. Mileage of roads practicable for motor vehicles is 4690. The "Layered Road Map of the Gold Coast" on the scale of 1:500,000 (1926), published by the Survey Department, is an instructive document.

Deficiencies in interior transport being thus made good, attention has been turned to the construction of an adequate port on this surf-bound coast completely lacking in natural harbors. A site was found in Takoradi, a short distance southwest of Sekondi. The new deep-water harbor was formally opened in April, 1928. An official description, "Takoradi Harbour and Railway Terminus, 1921–1928" has been issued in commemoration of the opening. The comments of the French press are illuminative: "un événement capital qui ne saurait laisser indifférents ceux qui s'intéressent aux colonies du Golfe de Guinée" (La Gold Coast et le port de Takoradi, *Renseign. Colon.* (*Suppl. à l'Afrique Française*), 1928, pp. 320–326)—with the exception of Dakar the ports of French West Africa are poor.

The future of the Gold Coast's great industry has caused some concern; fears have been expressed that the maximum development has been reached. There has been some falling off of productivity in the eastern area. Herein lies one of the weaknesses of the present system: the agricultural education of the native still has a long way to go. The larger part of the area of suitable land with the requisite amount of properly distributed rainfall (for a rainfall map see G. G. Auchinleck: Seasonal and Geographical Distribution of Rainfall in the Gold Coast, *Gold Coast Rev.*, Vol. 2, 1926, pp. 28–33) has been brought under cultivation, though there is available some land at present sparsely populated in the west and northwest of Ashanti. One phase of the problem that is causing worry to the administration is the deforestation that continues apace. "It is almost impossible to persuade the native that it is essential for the future of the crops and the water supply of his country that certain forest areas should be maintained. Practical difficulties arise from the unsettled state of the tribal administration, due to the frequent destoolment and deaths of the Chiefs, and also to inter-tribal friction, and the complexity of the land problem." This is the other side of the picture of native policy in British West Africa.

ASIA

Two Recent Geographical Studies of Rural India. The British have brought more than law and order to India. The elements of Western civilization introduced by them have modified Indian economic life in nearly all its aspects, rural and urban alike. Some of these modifications have been for the better, as in the case of the Deccan peasants. In the old days each Deccan village, "cut off from outside intercourse, was entirely dependent on its own production for its existence. Should the rain, upon which the crops depended fail, then starvation and death were the result, and it was not an infrequent occurrence on the Deccan. . . . Into this land of villages came the West, with its roads and railways, its irrigation works, and its commercial and scientific farming, perhaps to darken the bright side of the picture, but certainly to brighten the dark side" (Ethel Simkins: The Agricultural Geography of the Deccan Plateau of India, *Geogr. Teacher Suppl. No. 2*, London, 1926, pp. 72–73).

On the other hand the coming of "the West" has not always brought even material prosperity. This is shown in a recent study by Arthur Geddes, "Au pays de Tagore: La civilisation rurale du Bengale occidental et ses facteurs géographiques" (with preface by A. Demangeon; Paris, 1927?). In western Bengal the construction of railways has been the principal factor in modern times leading to widespread deforestation. The all too familiar results have followed the cutting down of the jungles: sudden floods, accelerated erosion of slopes, and silting of streams. For flood protection dikes have had to be built along the lower courses of the rivers that flow across the deltaic plains. Thus the rice fields no longer receive the benefits of the mud with which the floods formerly renewed their fertility, and no longer are the stagnant pools on the low lands periodically purged of the malarial scourge by the health-bringing flood waters. Mr. Geddes asserts: "In a word, the deforestation of the high grounds certainly seems to produce famine and mortal fever on the plains." It does not take very much in India to upset the delicate adjustment of man to nature.

The two publications cited above make clear the critical closeness of this adjustment. Miss Simkins brings out the relations between topography, soils, and rainfall on the one hand, and crop production, settlement, rural economy, and distribution of population on the other. In general the soils of the Deccan fall into two main groups: the regur, or black soils due to "subaerial weathering of either trap or metamorphic rock," and red soils, "overlying the metamorphic rocks of the Southern and Eastern Deccan, outside the trap area." On the regur soils jowar and bajri (varieties of millet), with cotton, are the main crops: the red loams are the rice-growing areas. In the jowar-bajri-cotton zones commercial agriculture has been most extensively developed; the rice areas, although they show commercial influences "as yet only slight," have the densest population. Although the land throughout most of the Deccan is tilled by small proprietors, in a small coffee-growing region along the edge of the Western Ghats "the majority of the coffee estates are owned and run by Europeans and worked with native labour . . ."

In conjunction with Miss Simkins' study reference may be made to a paper by J. N. L. Baker, "Notes on the Natural Regions of India," in the Summer, 1928, number of *Geography*. In the Deccan he recognizes as the major subdivisions the northwestern trap area of millets and cotton and the southern area of "rice and tanks."

Arthur Geddes is the son of Professor Patrick Geddes, founder of the Outlook Tower in Edinburgh, "a museum of civic geography with a world outlook" (*Geogr. Rev.*, Vol. 12, 1922, p. 432). The spirit of the Outlook Tower has been carried by the son into his present study. As Professor Demangeon writes in the introduction, Geddes "has made himself thoroughly acquainted with the Hindu spirit, even through contact with the great poet, Rabindranath Tagore." Geddes passed more than six months in the "sanctuary of Hindu intelligence and patriotism" that has been built up by Tagore some hundred miles northwest of Calcutta.

The Uriankhai Basin as a Border Region. A clear conception of the Uriankhai Basin as a Siberian-Central Asian border region is given by H. Hausen in a paper on the physiography of the Upper Yenisei drainage area. The Uriankhai Basin is the gathering ground of the upper waters of this great Siberian river. The basin is surrounded by mountains of "quite uniform physiognomy: flat-formed upland surfaces of general heights about 6000 feet and slopes dissected by narrow, rapidly descending valleys." On the north is the West Sayan chain which passes eastward and westward into ranges of snow-clad alpine peaks. On the south are the block mountains of the Tannu-Ola (the author spells "Tangnu-Ula" as approximating nearer the Mongolian pronunciation), which thus forms part of the hydrographic divide between the Arctic Ocean and the Central Asian area of interior basin drainage. The Uriankhai Basin, which occupies 150,000 square versts (about 65,000 square miles), is a depression of a Central Asian type, but it has an outlet to the north in the great S-shaped gorge of the Yenisei, "a remarkable hydrographic anomaly." There is a sharp contrast between the perfect drainage of the basin and the Northwest Mongolian Lakes region on the other side of the Tannu-Ola.

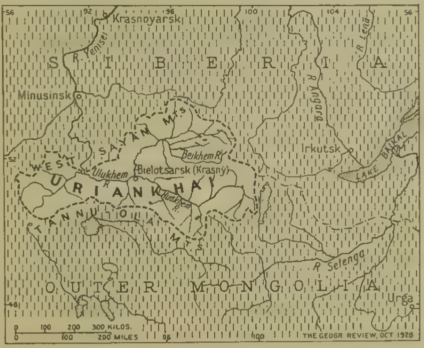

FIG. 1—Map to show the location of the Uriankhai Basin between Siberia and Outer Mongolia. Scale approximately 1:23,000,000.

The Tannu-Ola is forested on the northern slopes but is much drier than the northern mountains. Mr. Hausen considers that the West Sayan chain may be regarded as "the real divide between the humid mountainous *taiga* region of the Southern Siberian and the Mongolian steppes." On the vegetation of the Sayan area he mainly follows the excellent work of Henrik Printz (The Vegetation of the Siberian-Mongolian Frontiers (the Sayansk Region), Trondhjem, 1921). Printz recognizes four main phytogeographical divisions in the West Sayan: subalpine *taiga* or forest on both sides of the mountains; an alpine region above the tree line; a steppe area (Central Uriankhai steppe) of Mongolian or Central Asiatic stamp; a transition between *taiga* and steppe. He expresses the opinion that the steppe is gaining on the forest as a result of desiccation.

The native population is a mixed Mongolian tribe, called by the Mongols "Urian-khai," by the Russian "Soyoty." It is estimated that there are 40,000 of them living north of the Tannu-Ola, a boundary which Chinese and Mongolian authorities will not permit these seminomads to pass. The region has seen a considerable Russian emigration, first of gold seekers and merchants, of true settlers since the beginning of the present century. In 1912 as a result of the Russo-Mongolian treaty the region came under Russian protection, and colonization was more closely organized. An administrative center was set up at Bielotsarsk, and a survey of natural resources commenced. The civil wars of 1918 and 1919 brought chaos. For a short time following the cancellation of the autonomy of Outer Mongolia in 1919 the area again came under Chinese suzerainty, but on Soviet occupation of Urga it proclaimed its independence as the "Tannu Tuva Republic." Protests have been made by both China and Mongolia, but no settlement seems to have been reached; and meanwhile, according to the China Year Book for 1928 (pp. 377–378), "the 'Tannu-Tubin Republic' maintains direct relations with the U. S. S. R., a new telegraph line connects its chief populated center, Krasny (formerly Bielotsarsk) with Russia, and measures, similar to those inaugurated in Outer Mongolia, are being taken to strengthen the link between this region and Siberia." Apparently the independence of the Republic is recognized by Mongolia for it is shown without the boundaries of that country in the latest political map of Mongolia (1928, scale 1:2,000,000) put out by the Mongolian Minister of Education (described in the *Zeitschr. Gesell. für Erdkunde zu Berlin*, No. 7/8, 1927, pp. 429–430).

Mr. Hausen's paper is a part of a report which he has edited on a geological expedition to the Siberian-Mongolian frontier (1917–1920) organized and directed by Professor J. J. Sederholm of Helsingfors. The report also includes a historical review of the scientific work in the area and detailed geological observations on the itineraries of the parties of the expedition. It is published in the first number of *Acta Geographica*, a series inaugurated by the Geographical Society of Finland to deal with research on foreign lands in contradistinction to *Fennia*, which is devoted to the home country.

AUSTRALASIA AND OCEANIA

Problems of Tahiti. "Tahiti deserves to be highly regarded by physiographers, for it has been suggestive of new physiographic ideas to various visitors," says Professor Davis in describing the island as a physiographic type (The Coral Reef Problem, *Amer. Geogr. Soc. Special Publ. No. 9*, 1928, p. 259). This view is endorsed by Dr. Cyril Crossland, who indicates the scope of the problems that remain. "Tahiti has a real value to mankind in its history, geological, anthropological and social. Its geological story may yet, by affording the simplest case, give a clue of value to the puzzle of the coral reefs of the world" (The Island of Tahiti, *Geogr. Journ.*, Vol. 71, 1928, pp. 561–585). He gives a graphic account of both the border of the island and the interior with its striking conformation and vigorous growth of mountain vegetation, "stronger than what I recollect in the forests of Panama." The knife-edged ridges so characteristic a feature of the topography and "high cliffs at the heads of valleys with slender waterfalls after rains," he thinks, have been determined in large part by subterranean drainage and consequent landslides, "the result of rock structure peculiar to volcanoes which have reached this state of decay in the tropics, viz., the alternation of lava sheets of very different strengths, some of which have decayed more or less into clay." The significance of great porosity of the rock under similar conditions is pointed out by Chester K. Wentworth in a paper entitled "Principles of Stream Erosion in Hawaii" (*Journ. of Geol.*, Vol. 36, 1928, pp. 385–410), in which he lays stress on the underground drainage and on the relative importance of chemical as compared with mechanical erosion.

As regards the coral reef problem Dr. Crossland's views are opposed to those of Professor Davis. Where the latter sees subsidence and coral growth, the former sees reef decay. He denies the existence of the embayed valleys advanced by Davis in proof. As Professor Stanley Gardiner points out in the discussion of Dr. Crossland's paper, a further critical study of these valleys is desirable. Professor Setchell, who has studied the coral reef problem in Tahiti (Phytogeographical Notes on Tahiti, *Univ. of California Publs. in Botany*, Vol. 12, 1926), states in *Science* for August 10, 1928, his belief that all types of reef "not only may, but do, develop to their full expression under still-stand conditions of ocean level."

Dr. Crossland relates the question of the Tahitian reefs to the human history of the island. Where the reefs are absent the maritime flat which otherwise borders the island is absent: and the flat is the basis of Tahitian life, on it grow the staple crops. "Where the process [of reef decay] has gone farthest, on the northeast coast, the island is desert, but in many other parts the flat is reduced to a mere fringe of palms, almost without human habitations." As it is, the status of the Tahitians leaves much to be desired. According to Dr. Crossland the present population, native and half caste, numbers only about 5000; they are even now being supplemented by the hardier Chinese "who alone have the energy to cultivate the barren slopes above the cliffs, and some of the less forbidding valleys."

The asset of splendid reef-bound harbors is not capitalized. The strategic advantage of Tahiti has indeed long been realized. As long ago as 1846, when the Panama Canal project was first seriously mooted, the Legislative Council of New South Wales investigated the route via Tahiti (G. H. Scholefield: The Pacific, Its Past and Future, New York, 1919). The needs of the case are urged by L. G. Numile in *L'Économiste Français*, February 11, 1928. He discusses the rival merits of Papeete and Port Phaeton (Taravao Bay), favoring the latter with better shelter and adequate space for the utilities necessary in a great port.

POLAR REGIONS

Sub-Antarctic Islands. Very different conditions prevail south of latitude 40° S. from those existing in similar latitudes in the northern hemisphere where the large continental masses enjoy a climate generally termed "temperate." The southern extension of South America and the poorly defined Antarctic Continent are the sole large land masses. There are, however, a number of small isolated islands: Marion, Crozet, Kerguelen, St. Paul, and Amsterdam islands under the French Flag; and the Falkland, Sandwich, South Georgia, and South Orkney islands grouped into the Falkland Dependency of the British Empire. Bouvet Island lies midway between these two groups. Shrouded in mists and storms, with low temperatures and few days of sunlight, these islands present conditions very unfavorable for the development of life. In striking contrast the surrounding seas support a rich fauna and flora. Whales, seals, sea lions, and innumerable varieties of fish swarm in the waters, while sea birds are very numerous. On the islands elevation, cold, and high winds preclude tree growth; and the vegetation, sparse and of few varieties, is largely confined to the littoral. The few native animals have been supplemented by introduced species such as goats, pigs, rabbits, and rats, in some cases adversely affecting the flora, barely capable of holding its own against the unfavorable environment (Camille Vallaux: La vie dans les petites îles australes, *Bull. l'Inst. Océanogr. No. 512*, March 15, 1928, Monaco).

Although these islands have been known for over two hundred years, only one group, the Falklands, has been colonized. Sheep raising, the basis for the successful colonization of the Falklands, is being attemped on Kerguelen Island with indifferent success (*Geogr. Rev.*, Vol. 17, 1927, p. 498). At present the sea life of the area constitutes its sole economic importance. Seals have been almost exterminated by the numerous drives against them; whaling is now the most lucrative occupation, and ships of many nations may be found in these waters.

The whaling industry has been the cause of some very interesting developments in the region. Having in mind previous depletions of whaling grounds, and with an eye to the conservation of the industry, the British have assigned two ships to a systematic study of the situation. The report for the first year's work ("*Discovery* Expedition: First Annual Report, 1926," London, 1927; Stanley Kemp: The *Discovery* Expedition, *Nature*, No. 2974, Vol. 118, 1926, Oct. 30, pp. 628–632) describes the work accomplished in the neighborhood of the Falklands and South Georgia. In connection with a study of the feeding habits a valuable study of the plankton was carried out. A marine station was established, and 738 whales were examined. In 1927, with the addition of the second ship, the *William Scoresby*, six lines of plankton stations were made between Cape Town and the Falklands (Stanley Kemp, The *Discovery* Expedition, *Nature*, No. 3055, Vol. 121, 1928, May 19, pp. 795–799).

Norwegian whalers who, although they almost monopolize the industry in certain localities, are forced to obtain most of their concessions from Great Britain, have also been active in exploration and in search for new whaling grounds. Heading towards the southern Pacific from South Georgia, Eyvind Tofte in the *Odd I* in January, 1927, located Peter I Island. This tiny islet, five miles in width by eight miles in length, was discovered by Bellingshausen in 1821 and later seen by Charcot in 1910. It was not found possible to make a landing, but the Norwegian expedition photographed the island from all sides (Charles Rabot: Une reconnaissance dans l'Antarctique: l'île Pierre Ier, *La Nature*, No. 2768, Sept. 1, 1927, pp. 220–221). A description of the island, nine-tenths of which is covered by snow or ice, is given by Eyvind Tofte in *Norsk Geografisk Tidsskrift* (Vol. 1, 1927, pp. 462–472).

The following season Lars Christensen, backer of the *Odd I* Expedition, outfitted the *Norwegia* for exploration along Enderby Land. In December, 1927, the expedition landed upon Bouvet Island, where a stay of almost a month was occupied in whaling, sealing, and scientific studies. During the cruises around Bouvet Island the *Norwegia* struck a rock, and the trip to Enderby Land had to be postponed in order that repairs might be made. Subsequently two of the scientists, Prof. Holtedahl and Dr. Olstad, made collections in the South Shetland Islands.

An international complication has arisen from this last expedition. The Captain of the *Norwegia* on landing took possession of Bouvet Island in the name of Norway. At the same time the British Government announced the lease of the whaling rights to the island to a Norwegian whaling concern. Great Britain bases her claim on the fact that an English whaler named Morris landed on what he called Liverpool Island and took possession of it in the name of King George IV. Discovered by Lozier Bouvet in 1738, this island eluded the attempts of Cook and Ross to relocate it. Meanwhile Morris and other whalers discovered Liverpool, Lindsay, and Thompson islands in the vicinity. Finally the German *Valdivia* Expedition in 1898 relocated Bouvet Island but at considerable distance from the position given it by its discoverer. The consensus of opinion is that all these islands are the one Bouvet Island which Great Britain claims because of the act of Morris. Norway, on the other hand, claims that if Liverpool and Bouvet islands are one and the same, Great Britain has neither colonized the island nor, as in the case of her other Antarctic possessions, issued any "Orders in Council" proclaiming her sovereignity ("The *Norvegia* Expedition and Bouvet Island," by Consul Bjarne Aagaard, Oslo, 1928). The matter is still under discussion (Charles Rabot: L'île Bouvet, *La Nature*, No. 2784, May 1, 1928, pp. 387–389; *Current History*, Vol. 27, 1928, p. 907).

Nature for March 31, 1928, states that Lars Christensen has decided to establish a radio and meteorological station on Bouvet Island. Such a step would be important in the scheme for establishing sub-Antarctic meteorological stations to supplement that on the South Orkneys taken over by the Argentine Meteorological Office.

THE OCEANS

The Greatest Ocean Depth. For the past decade and a half the greatest known oceanic depth was that found by the German surveying ship *Planet* in 1912 about 40 miles east of the island of Mindanao, Philippine Islands, where a sounding by wire gave a depth of 9788 meters, or 32,113 feet. A still greater depth was found last year in this region by the German cruiser *Emden*. The *Nachrichten für Seefahrer* for May, 1927 (p. 465) reports the discovery by the *Emden* of a depth in excess of 10,000 meters. Since the *Emden* employed an echo-sounding apparatus, the exact depth depends on the value taken for the velocity of sound in sea water, which depends on the temperature, salinity, and pressure of the column of water through which the sound is transmitted. Adopting the most probable values for these variables, H. Maurer derives the depth found by the *Emden* to be 10,793 meters, or 35,410 feet (*Zeitschr. Gesell. für Erdkunde zu Berlin*, 1927, p. 340). This depth was found about ten miles southeasterly from the *Planet* depth. Maurer reports further that the *Emden* made several hundred soundings in that region, of which 46 gave depths in excess of 10,000 meters.

H. A. Marmer

MATHEMATICAL GEOGRAPHY

A Rapid Method of Determining Position at Sea. It is universally agreed by navigators that two observations are necessary in order to get a fix at sea. There is no exception to this rule nor ever can be. In the middle of the day in summer time two observations of the sun, separated by about two hours, will frequently give two Sumner lines which intersect at a large angle and thus give a satisfactory fix. At dawn and dusk a planet may be useful; and after dark two stars suitably placed, when the horizon is visible, will permit two observations for the same purpose. The books also give as a special case an observation on the prime vertical for a body very near the prime vertical, by which latitude and longitude may be secured at the same time but not in a single observation, one observation being for altitude and the other for the rate of change in altitude.

Mr. Edward J. Willis, author of the excellent volume "The Methods of Modern Navigation" (New York, 1925), now comes forward with an appendix to this volume under the title "The Line of Azimuth" (1928), presenting a method of securing a fix within a comparatively brief time by means of a Sumner line and the line of azimuth, the latter being based upon an observation of the rate of change in altitude of the observed body.

This method differs radically from the process on the prime vertical and is asserted to be available except when the object is near the meridian. It is, of course, a fact that the rate of change of altitude for any given latitude is dependent on the azimuth of the body, and the rate may vary from zero to not exceeding one minute of arc in four seconds of time.

The Appendix shows mathematically how, given the altitude and the rate of change of altitude of any celestial body, the observer's position is definitely established; and a short and simple equation is given for the observer's latitude, containing only these two quantities and the object's declination. There is also given a similar equation for the observer's hour angle from the object and hence the observer's longitude. The two formulae are easily worked, and the reader need not fear coming into relation with the calculus; for, although in the establishment of the equations the dubious quantity dA/at occurs, the calculus for practical purposes ceases at this point, and from there on the calculation for position deals only with the long-familiar logarithmic sines, cosines, tangents, etc. of altitude declination, latitude, hour angle, etc. Even the dubious quantity dA/at need not be greatly feared, for it is only a short name for the rate of change of altitude, i. e., in plain English, a fraction with a few minutes of arc for the numerator and a few minutes of time for the denominator.

The method set forth by Mr. Willis is almost wholly dependent on the rate of change of altitude, which is not nearly as easy to observe as altitude. This is almost the only serious objection that can be offered. In 1853, Prestel showed that latitude could be obtained from the rate of change of altitude, when the object was on the prime vertical, and made use of the sun's known diameter in minutes as the numerator of the fraction above referred to. Mr. Willis extends this method to any azimuth and thus makes it general and available at all times except near the meridian when, of course, the usual meridian calculation for latitude should be used. It is really the quickest way known to obtain a position at sea and on this account may be of vital service in emergency, for the two observations require only three or four minutes in summer and six or eight in winter, and the calculation is short and easy. The only difficulty is that conditions must be favorable and the observations must be carefully taken to obtain good results in so short a time.

To get greater accuracy, Mr. Willis offers also a method of obtaining the rate of change of altitude from the difference of three altitudes taken at equal intervals of from fifteen minutes to half an hour, as the observer deems advisable. In summer about fifteen minutes gives excellent results, and in winter about half an hour. In practice the third observation is actually made up from two observations made just before and just after a calculated time. Prestel's method of observing the rate of change of altitude will, together with Mr. Willis' equation for latitude, give a position always on the Sumner line but not the exact place on the line. The three-altitudes method gives the observer's position on the line with accuracy, assuming, of course, the work to be properly done.

As to the accuracy of the results obtainable, the author has expressed the opinion that, under favorable circumstances and by the use of the quicker and less accurate method, the ship should be within five miles of the fix obtained. If the Sumner line problem is also worked, this would narrow the space of uncertainty to a width of a mile or two on each side of the line.

If, on the other hand, the more accurate method, also given in the pamphlet, is used, requiring from half an hour to an hour in observing, the probable error would be appreciably less, varying considerably, of course, with the skill of the navigator in making the observations.

The importance of using the line of azimuth obtained by either method lies in the fact that a fix may be obtained by means of it which could not be had in any other manner and which may be of vital importance. It would seem, therefore, that the navigator cannot afford to be without a knowledge of the new method given in this pamphlet. It can be obtained for 25 cents from the publisher, R. Massie Nolting, P. O. Box 411, Richmond, Va.

Charles E. Manierre

PHYSICAL GEOGRAPHY

The Problem of Past Climates. In an admirably frank and instructive paper G. C. Simpson treats three important problems of past climates (*Quart. Journ. Royal Meteorol. Soc.*, Vol. 53, 1927, pp. 213–232). These problems are the supposedly subtropical temperature in the polar regions and the slight difference of temperature between equatorial regions and polar regions during long periods of the earth's history; the last ice age; and the former existence of glaciers at sea level within the tropics.

The view that the assumed uniform climate in the northern hemisphere was due to vast oceanic currents carrying warm water to the polar regions is based on an entirely wrong conception of the physical causes which maintain the existing climatic zones. Great quantities of heat and cold are transported by the general air circulation from equatorial regions to polar regions, and vice versa. Other large quantities of heat and cold are carried by the ocean currents, which, driven almost entirely by the wind, are dependent on the intensity of the general circulation of the atmosphere. This latter, however, depends for its energy on the difference of temperature between equatorial regions and polar regions. There are thus two opposing factors, viz. (1) the temperature difference which induces the general circulation and (2) the general circulation which tends to eliminate the temperature difference. Hence, and because of the inertia and other properties of the atmosphere preventing complete equalization of temperature, the final results of new warm currents to the polar regions would be little or no change of temperature. There must always have been temperature zones similar to those which exist today.

The temperature gradient between the equator and the poles and the average temperature of the zones are found to be largely independent of the distribution of land and sea. But, while the nature of the earth's surface plays a small part in determining the average temperature of a zone, it plays a large part in determining the actual temperature in various parts of the zone. Thus, the temperature is highest over the east of the oceans, because the chief transport of warm air from equatorial regions takes place here; and it is lowest over the east of the continents, because the return flow of air from the polar regions mainly occurs here. The magnitude of the induced difference is limited; the highest temperatures over the North Pacific Ocean are within 3° C. of the highest temperature in the narrow North Atlantic with its Gulf Stream; and the lowest temperature of any latitude over North America is almost exactly the same as the lowest temperature on the same latitude over Asia, which is more than twice as broad.

With another distribution of land and water and other ocean currents we should have the same average temperature. Greater variations of temperature than at present are not easily conceivable. Therefore it seems that at no time in the past is even a limited region of the earth's surface north of latitude 40° likely to have had a higher or lower mean annual temperature than can be found somewhere on the same latitude today. The same limits of temperature would obviously apply to the southern hemisphere also.

If, then, readjustment of land and sea would not alter the mean temperature of the zones, can the Quaternary glaciation have been caused by increase of the land area or by raising of the land surface? The answer is no.

The Greenlandic ice sheet is for the most part more than 1000 meters high. Greenland on the east and the west is bathed by cold oceanic currents which produce very low summer temperature. The conditions for ice formation in Greenland are thus extremely favorable in comparison with what they would be on an uplifted Scandinavia. Since, furthermore, the Greenlandic ice is a relict from the last glaciation which just balances supply and wastage, how could an ice sheet form in Scandinavia?

Can glaciers at sea level within the tropics be brought about by any arrangement of land and water? The answer is no.

In the high Himalayas the snow line lies about 5000 meters above the sea, and the glaciers terminate above the level of 3000 meters. As the normal fall of temperature with height is 6° C. per 1000 meters, a temperature fall of more than 18° C. would be necessary if temperature were the only factor. A general temperature fall as cause is out of the question, since the temperature of the zone is fixed so long as solar radiation and the nature of the atmosphere remain unchanged. A sufficient local temperature fall by a redistribution of land and water is inconceivable. Within the equatorial belt the lowest mean temperatures are met over the sea. The coldest spot in the tropics at present, which is produced by a cold ocean current off the coast of Chile, has a temperature of 18° C., i. e. 16° C. above the maximum temperature deduced to be allowable if the glaciers of the Himalayas are to expand to sea level. Increased snowfall cannot be the cause, since it is difficult to conceive of any conditions more favorable for snowfall than those existing in the Himalayas.

Thus, "meteorology is unable to offer a solution of the three main problems of past climates," though "a consideration of them led an eminent meteorologist [Köppen, in Köppen-Wegener, "Die Klimate der geologischen Vorzeit"] to point a way out."

Ernst Antevs

HUMAN GEOGRAPHY

Railway Zone Pattern As an Indication of Economic Development. Professor Jefferson illustrates his paper, "The Civilizing Rails" (*Econ. Geogr.*, Vol. 4, 1928, pp. 217–231) with a striking series of black-and-white maps of the continents. On a black ground is shown the "useful neighborhood" of the railway by a white band, arbitrarily selected as within a distance of ten miles. Certain distinctive patterns may be recognized in the arrangement of these "bands of mobility"—the "web," the "net," the "tentacle," the "river link," corresponding to certain stages of economic development of the regions concerned. The rail web is a white patch produced by overlapping bands, where "the lines and threads of communication are lost in one great fabric of easy transportation, extended and continuous." Such obtains in western Europe, exclusive of the Scandinavian uplands and the Iberian Peninsula; in eastern North America as far west as the 100th meridian, an aridity barrier (less than 20 inches of rain) and into Canada south of the Canadian shield. On the Argentine pampa there is a smaller web, also limited westwards by an aridity barrier (less than 20 inches (550 mm.) of rain: this is discussed by Franz Kühn in "Capitulos de Geografía económica Argentina, *Anales de la Facultad de Ciencias de la Educación*, Universidad Nacional del Litoral, Paraná, Vol. 3, pp. 65–99, 1928) and incipient webs about Rio de Janeiro and São Paulo.

The separate bands appear in the rail net. Examples are seen in Spain and Portugal, Russia, and the Balkans. In Russia the strands show an interesting "cobweb" effect (compare Fig. 10, p. 636 of this *Review*), as for instance around Moscow, resulting from facility of construction on the plain together with planning by central authorities, a pattern of "autocratic rule." The rail web of North America is continued westward to the Pacific and south through Mexico by a rail net. The Atlas region, South Africa, and southeastern and southwestern Australia have rail nets. In the vast extent of Asia only Japan and India have progressed so far. "Nothing could put England's contribution to the civilizing of India in a clearer light than this map of the Indian rail net with its thickening in the valley of the Ganges."

Beyond the rail net stretches out the railway tentacle. North American examples are the line to the Peace River District and the line now building to Hudson Bay, to the new terminus at Fort Churchill (see F. Palmer's "Report on the Selection of a Terminal Port for the Hudson Bay Railway," October, 1927), replacing Port Nelson. Most of South America's railroads are essentially of the tentacle type. The longitudinal railroad of Chile, for instance, was built primarily for strategic purposes; economically it is the branches from the sea that are important. The Russian railways in Asia are striking examples of tentacular development. The river link type is characteristic of undeveloped regions where rivers are the main highways. The line around the Madeira Falls in Amazonia is one of several examples from South America.

GEOGRAPHICAL NEWS

Memorial to Lieutenant Commander George W. De Long. A memorial to Lieutenant Commander George W. De Long, the heroic leader of the ill-fated expedition of the *Jeannette*, 1879–1881, and to the officers and men of his command was unveiled on July 4 at Woodlawn Cemetery, New York. The ceremony took place in the presence of Mrs. De Long and a number of explorers who had gathered to pay tribute to his memory. The act of unveiling was performed by Lieutenant De Long Mills, a grandson, and Mr. Herbert Wood Leach, only survivor of the *Jeannette* expedition now living. Captain Sir Hubert Wilkins, Vilhjalmur Stefansson, and Anthony Fiala spoke of the value of the work accomplished on the *Jeannette* during its long drift in the Arctic pack, precursor of Nansen's drift in the *Fram*. General Greely has summarized the achievements thus: "Apart from valuable physical observations in an unknown region, the geographic results of this expedition were extensive and important. They covered some 50,000 square miles of polar ocean, and clearly indicate the conditions of an equal area between their line of drift and the Asiatic coast. De Long proved that the Siberian Ocean is a shallow sea, dotted with islands . . ." (A. W. Greely: A Handbook of Polar Discoveries, Boston, 1909, p. 192).

OBITUARY

DR. OTTO NORDENSKJÖLD. Dr. Otto Nordenskjöld, professor of geography at the University of Göteborg, died in Göteborg on June 2, at the age of 58. Dr. Nordenskjöld's contributions to polar geography are very great, both in his investigations of specific problems, as for instance, his glaciological studies in Greenland and the Antarctic, and in his power of broad synthetic generalizations, as exemplified in his work "Polarnaturen" (Stockholm, 1918), of which an English version, "Polar Nature: A General Characterization," forms part of "The Geography of the Polar Regions" (*Amer. Geogr. Soc. Special Publ. No. 8*, 1928). Dr. Nordenskjöld early followed in the steps of his distinguished uncle, Baron A. E. Nordenskiöld, the first to accomplish the Northeast Passage. In 1895 he organized an expedition to the Magellanic lands for geological, botanical, and zoölogical study (Wissenschaftliche Ergebnisse der Schwedischen Expedition nach den Magelländern, 1895–1897, 3 vols., Stockholm, 1905–1907). Immediately on his return he engaged in plans for Antarctic research, a subject which then, thanks largely to the interest roused at the International Geographical Congress of 1895, was attracting international attention. Nordenskjöld's efforts materialized in the Swedish South Polar Expedition, 1901–1903, whose base was established on the east coast of Graham Land. In the rich harvest of scientific results (Wissenschaftliche Ergebnisse der Schwedischen Südpolar Expedition, 1901–1903, 7 vols., Stockholm, 1908–1921) particular interest attaches to the observations pointing to the former connection between Graham Land and the South American continent. A popular narrative of the expedition in English, "Antarctica," appeared in 1905.

The polar regions continued to exercise their "mystic force" on the explorer, and later years found him in collaboration with English friends for an "Anglo-Swedish Antarctic Expedition," of which he was to be leader and which was to have taken place in 1915. It was frustrated by the war; but both before and after this interruption he visited various Arctic regions, Greenland ("On the Geology and Physical Geography of East Greenland," *Meddelelser om Grönland*, Vol. 28, 1908), Spitsbergen, and Iceland, enriching his store of knowledge of that polar nature, which is "not so strange," he himself said, "for those who live in northern countries."

Mention must also be made of Dr. Nordenskjöld's interest in South America. In 1920–1921 he again visited that continent, traveling through Chile and Peru. One phase of the geography of these lands that attracted his attention was the problem of foreign colonization. His views are contained in his work, "Sudamerika: Ein Zukunftsland der Menschheit," Stuttgart, 1927.

GEOGRAPHICAL REVIEWS

INDUSTRIAL NORTH AMERICA

STEN DE GEER. **The American Manufacturing Belt.** Maps, ills. *Geogr. Annaler,* Vol. 9, 1927, pp. 233–359.

American geographers will be glad of this admirable work of the well-known Swedish geographer, in great part the result of his visit to this country in 1922.

He outlines our great industrial region as the southern three-quarters of the New England, Middle Atlantic, and eastern North-Central States, omitting the coastal islands and peninsulas. His criterion of industrial activity is the number of wage earners in a city, which the census enumerates for all cities of 10,000 or more inhabitants. His main map locates these cities as dots of size proportional to the number of wage earners and draws the boundary of the industrial region by assuming that all cities within 53 miles of one another (this "absolute maximum distance" is that between Detroit and Toledo and between Cleveland and Ashtabula) belong together. There are 353 of them listed. Many local centers of industry occur outside, of course. The author describes the rise of manufacturing in the old world and in this country and provides basis for comparison by a map of Sweden's industrial region and a city list with data.

The treatment goes into the geography of industry, comments for instance on the pessimism current with regard to New England's cotton manufactures, and points out that the South cannot hope in the long run to retain more than a single one of her advantages over New England—that of nearness to the cotton fields—the others being pretty sure to disappear with the progress of southern industry. Easily read tables show that most cities even in New England are increasing their number of wage earners from census to census, only Lowell losing as much as 2000. De Geer points out that even dominant industries rarely occupy as many as half the workers of any city. Studies of the principal industries developed are made. Railways, especially those of the manufacturing region, come in for a most illuminating treatment, with a sketch of their history and past and future groupings. Attention is paid to the influence of past waterways as well as the roads of the region, and De Geer shows intimacy with the books on the subject, though his treatment is original and novel.

The paper is in English and exceedingly smooth and flowing English. It appears to the reviewer highly geographic in that it attempts to set before us the totality of the environment in which men have wrought here instead of limited aspects of it.

MARK JEFFERSON

A STUDY IN AGRICULTURAL GEOGRAPHY

HERTHA CROHN. **Der Mais in der Weltwirtschaft.** 64 pp.; maps, diagrs. *Veröffentl. Inst. für Meereskunde, V. Hist.-volkswirtsch. Reihe, No. 5,* August, 1926.

Dr. Crohn has added a useful, if brief, monograph to the literature of agricultural geography. This is a survey of the geography of maize (corn) production, trade and utilization, and it is good geography. Throughout there is a careful emphasis on the interrelationship between significant elements of the natural environment and the location of margins of the several maize-producing regions, the character of the grain, and the methods of production.

Most of the facts reviewed in this study of maize are known to American geographers, particularly to those well acquainted with the corn belt. The author introduces the crop through the region of its origin, sets up climatic and soil optima for its cultivation in extra-tropical regions, and discusses its comparative economic values. The next step in the presentation is a word picture of the world regions of corn production. This is supplemented by a small-scale but carefully prepared dot map of the world distribution of corn-producing areas (Mercator's projection).

The major part of the publication consists of a series of sections, each one dealing with the details of the geography and economics of maize production, consumption, and export in one of the important maize regions. These sections are organized on the following plan: (1) climatic conditions responsible for the limits of the maize-growing region, (2) topographic and soil conditions characteristic of the region, (3) economic conditions and agricultural practices associated with the crop, and (4) the rôle of maize in the food economy and in the foreign trade of the region.

The paper as a whole displays a broad knowledge of the literature of regional agronomy. Certain statements indicate lack of familiarity with local conditions. For example it is indicated (p. 12) that in the United States maize covers about 40 per cent of the cultivated land; and again (p. 14), after comments on the favorable character of the convectional showers with maximum precipitation in June, it is stated that the ensuing warm dry period of the "Indian summer" permits a proper ripening of the maize ears. On the contrary, other statements are most illuminating, notably the frequent reference to the significance of corn culture and corn utilization among the hill and mountain farmers of various regions, such as northern Italy and western Rumania.

V. C. FINCH

THE EARTHQUAKE PROBLEM IN SOUTHERN CALIFORNIA

R. T. HILL. **Southern California Geology and Los Angeles Earthquakes, With an Introduction to the Physical Geography of the Region.** xvi and 232 pp.; maps, ills. Southern California Academy of Sciences, Los Angeles, 1928. $5.00. 8 x 5½ inches.

The predictions made several years ago by Bailey Willis, professor of geology emeritus at Stanford University, widely experienced in studies of earthquakes, to the effect that a severe shock is likely to occur in southern California in from three to ten years, are now contradicted in a book by R. T. Hill, widely known for his excellent geological work, especially in Texas. Hill's argumentation is partly inductive, partly deductive. He announces inductively: "Experiences of the past show that no moderately well-constructed buildings has [*sic*] ever been destroyed by earthquakes in Southern California." After 100 pages on the numerous rifts of the region, to which its leading physiographic features are in great measure due, he concludes deductively that the rift movements were largely responses to the depression of the ice-covered part of North America during the Glacial period and that, as we are now in an interglacial epoch, further rift movements of a serious nature are unlikely.

Hill's book will probably be quoted as convincing by realtors who have building lots to sell around Los Angeles; for it has the style of a legal brief, prepared to defend the interests of a client rather than that of a scientific monograpn prepared to set forth impartially all the pros and cons of a highly theoretical and very debatable problem. For example, it is told that "the authorities of the University of California at Los Angeles, by permitting the new buildings . . . to be built almost astride of this line [an allegedly dangerous fault line a few miles west of Los Angeles center] have shown their lack of fear of harm from it." But it is not told that the same authorities permitted the construction of a great stadium at Berkeley a few years ago and are now permitting the erection of a $300,000 dormitory, the first directly astride, the second close alongside of the Hayward rift or fault line, on which very considerable displacements have taken place in the geologically recent past and on which an earthquake occurred in 1868, similar in violence to that of San Francisco on the San Andreas rift in 1906. It would therefore seem that the lack of fear of harm on the part of the university authorities is not closely related to the lack of stability on the part of the earth's crust.

When the book was first placed on sale it had a red-paper cover on which the purchaser was most erroneously informed, directly over the imprint, "Published by the Southern California Academy of Sciences": "This book completely refutes the predictions of Professor Bailey Willis that Los Angeles is about to be destroyed by earthquakes. It proves that this area is not only free from a probability of severe seismic disturbances but has the least to fear from 'Acts of God' of any [*sic*] city under the American flag." So glaringly false are both these sentences that they have been suppressed and replaced by a milder statement on a later cover; but on both covers we read in a following paragraph: "Here are [*sic*] first given . . . an explanation of the natural causes of our beautiful scenery and charming climate."

A list of errata closes with a note: "In justice to the author it is proper to state that this book was printed without awaiting his final corrections upon the last galley proofs and page proofs." One who knows Hill's other publications must wonder how far his failure to see the final page proof is responsible for the actual form of this book; and one who is familiar with publications of academies of science in general must wonder what sort of an editor or proof reader was employed for Hill's book by the Southern California Academy.

Not enough is yet known of earthquakes in general or of Southern California earthquakes in particular to warrant either predictions of their occurrence or assurances of their non-occurrence; but enough is already known to make safe building construction a wise public policy.

W. M. Davis

First Geological Report of the Central Asian Expedition

C. P. Berkey and F. K. Morris. **Geology of Mongolia: A Reconnaissance Report Based on the Investigations of the Years 1922–1923.** xxxi and 475 pp.; maps, diagrs., ills., bibliogr., index. (Natural History of Central Asia, Vol. 2.) American Museum of Natural History, 1927. $10.00. 11 x 9 inches.

With this substantial volume the American Museum of Natural History has commenced publication of the scientific results of the Central Asian Expedition. It is mainly occupied with the geological observations along 5000 miles of route traversed in 1922 and 1923 and in the special localities chosen for detailed study. An introduction gives the historical setting of the problem and defines the Gobi region, the theater of the expedition's activities. Reference should be made to the two maps showing respectively the routes of Russian and of non-Russian geologists in Central Asia and to the extensive bibliography. On the north the boundary of the Gobi region follows the Arctic watershed along the fault block range of the Tannu-Ola and the domed masses of the Khangai and thence along the Transbaikal block mountains; the eastern boundary is the Great Khingan; southern and western boundaries are less easily defined, but on the south the Gobi region is considered to include the southern Ordos and on the west the Dzungarian and Lop Nor basins. Thus is enclosed a basin 600 miles by 1000 miles, a vast shallow depression, an alternating succession of broad nearly level plains separated by more rugged areas of the uplifted and dissected hard rock floor (the area was briefly described by Mr. Morris in "Notes on the Mapping Program of the Third Asiatic Expedition in Mongolia," *Geogr. Rev.*, Vol. 14, 1924, pp. 287–292).

The routine account of the geological record is illustrated with informative sketches and diagrams and enlivened with observations on the character of the country and its inhabitants, as for example, the grassland belts of the northern and southern borders. Of the former, at Sain Noin, it is observed that "the valley bottoms are well grassed, flocks and herds are numerous, and more people live in them than we had seen hitherto in any part of the journey" (p. 125). On pages 183–184 is a brief but arresting description of the southern belt now being colonized by Chinese farmers, and the many excellent photographs include one of the grainfields of the colonists (facing p. 48). Concluding sections summarize the structural elements of the old rock floor and the fossiliferous sediments and discuss the surface features and their origin. Of special geographical interest are the observations on climatic change. This area, with its peculiarly delicate climatic balance as regards animal and human life, is of critical importance. From evidences of old river courses and misfit streams, ancient lake beaches and terraced dissected alluvial fans, the outpost forests of the Arctic divide, and the like, it is concluded that "fluctuations have been many and of very unequal intensity and duration." As yet it has not been possible to correlate the fluctuations or assign dates to them, but it is stated that "observations made in 1925 throw a flood of light on the problem of climate in Pleistocene and Recent times." For this and for amplification of other matters dealt with in this volume, which necessarily is of a preliminary nature, further publications of the Expedition will be awaited with the greatest interest.

THE FACTS ABOUT THE EARTH'S ATMOSPHERE

SIR NAPIER SHAW. **Manual of Meteorology, Vol. II: Comparative Meteorology.** xxxix and 445 pp.; maps, diagrs., index. The University Press, Cambridge, 1928. 36s. 10½ x 7½ inches.

This is the third of a series of four volumes which the former Director of the Meteorological Office set as a task for himself when he laid down his official duties. In this case, certainly the last shall be first, for Volume IV, dealing with the relation of the wind to the distribution of pressure, appeared in 1919 (see review in *Geogr. Rev.*, Vol. 10, 1920, pp. 55–56) and Volume I, "Meteorology in History" in 1926 (see review in *Geogr. Rev.*, Vol. 17, 1927, pp. 687–689). Volume III is yet to come.

No one has done more to develop our knowledge of air motion, air stratification, and what we may call the dynamics of the atmosphere, than Sir Napier Shaw. By training a physicist, with a long experience as teacher and even longer in prominent official capacities, he has had opportunities which can come to but few men; and always he has made wise use of his privileges.

What first strikes the reader is the solid character of the book and the almost lavish use of maps. After a first chapter, giving the energy in kilowatt hours for both northern and southern hemispheres received by direct radiation, with a solar constant of 135 kilowatts per square decameter, we meet the first of the maps in Chapter II, which deals with land, water, and ice; also orographic features and other geophysical agencies. It is acknowledged that the type of map used (circumpolar) has its limitations and shows distortion in equatorial regions, and so special maps (Mercator projection) are employed from 30° N. to 30° S. A mere list of the maps and graphs found in this chapter tells the story of accumulated records in many directions better than if described in several pages of text: these are snow lines and highest mountains, sea ice and icebergs, ice limits, earthquakes, magnetic variation, auroras, and thunderstorm frequency.

Chapter III deals with the composition of the atmosphere—a rather familiar tale.

Chapter IV is a book in itself, dealing with temperature. The list of references requires four closely printed pages. There are 37 maps showing the distribution of temperature for each month at sea level, also mean daily and mean seasonal ranges.

Upper air data are given quite fully, and near the end appear certain departures from the usual Cartesian ordinates of temperature and height in favor of what he calls potential temperature, which is temperature corrected for difference of pressure. In other words, the reasoning is now on a thermodynamic basis. Shaw himself is responsible for introducing the conception of the entropy of a mass of air, which he finds to be proportional to the logarithm of the potential temperature. This enables him to construct new diagrams—in fact improved indicator diagrams; and we have, for example, in Figure 63, the "Variation of Realised Entropy" in a section of the upper air from the Arctic to the Antarctic. The entropy increases but slowly with height in the troposphere but rapidly in the stratosphere. All of which throws light upon the stability of the atmosphere. If the adiabatic runs forward above the graph, saturated air in that position would be unstable, or, as Shaw prefers, "unsistible"; while, if the adiabatic passes to the right of the point where it cuts the graph, even saturated air would be sistible and stable. This is tough chewing for the layman but rich meat for the engineer. We must regard Shaw as doing for air engineering pretty much what Rankine did with his tables for steam engineering.

Chapter V has 83 pages devoted to water vapor. Fog, cloud, and rainfall maps are given *in extenso*. Chapter VI deals with pressure and wind, and Chapter VII with the general circulation and the new concepts of resilience or plasticity. Here too may be found long records of weather, those in our own country being the New Bedford (Rodman) observations from 1814, Baltimore rainfall from 1817, Boston rainfall from 1818 continuous (and interpolated from 1750), and Philadelphia from 1820.

After a voluminous discussion of correlation coefficients, the author remarks that the general impression he derives from it all is bewildering. And in this view most of us will agree. He also says that the relation to solar changes through sun-spot variations is similarly unimpressive. So it would seem that a vast amount of effort has been expended with practically no result so far as ability to utilize these values in forecasting is concerned—which at present is the great desideratum.

Chapter VIII treats of cyclones and anticyclones. Chapter IX is largely on forecasting and some new views of cyclones and anticyclones; and the final chapter sets forth a series of forty-five articles expressing conditions between 4 and 8 kilometers (400 and 800 geodekameters in the new parlance) and their relations with the air strata above and below.

ALEXANDER MCADIE

RAINFALL ATLAS OF THE BRITISH ISLES

Rainfall Atlas of the British Isles. 12 pp.; maps. Royal Meteorol. Soc., London, 1926. 15s. 12½ x 10 inches.

The "Rainfall Atlas of the British Isles" is a very welcome publication. In convenient and compact form, by means of many clear and effective colored charts, it gives a complete and vivid presentation of the essential facts. The frontispiece is an orographical map, showing contour lines, principal rivers and towns, and county boundaries. What a help it would be if the rainfall maps of all countries were invariably accompanied by an orographic map!

Three full-page maps, on the scale of 60 miles to an inch, show the mean annual rainfall (1881–1915), the rainfall of a very wet year (1872), and that of a very dry year (1887). A series of fifty-six half-page maps show, for each year from 1868 to 1923, the annual rainfall expressed as a percentage of the average. There are twelve full-page maps showing the mean monthly rainfall, based on the 35-year period 1881–1915. On all these maps the counties are indicated, with abbreviated names. The mean annual map gives isohyets for 20, 25, 30, 40, 50, 60, 80, 100, 150, and 200 inches. On the monthly maps they are drawn for 1.5, 2, 2.5, 3, 3.5, 4, 5, 6, 8, 10, 15, and

20 inches. The English and the metric units are indicated on opposite sides of the scale of tints. The color scheme is well chosen, and the details of rainfall distribution can very easily be seen.

Dr. Hugh Robert Mill, the recognized authority on the rainfall of the British Isles, has most appropriately written the introductory text. He gives a brief historical summary of the work on rainfall in the British Isles, and a description of the individual maps in the Atlas.

On the mean annual map five districts with rainfalls over 40 inches are shown, on or near the west coasts of Ireland, England, and Scotland. In Wales, "the mountain valleys of Snowdon in the north have a rainfall exceeding 100 inches, culminating in Llyn Llydaw, one of the wettest spots in the British Isles, where the average probably exceeds 200 inches." At the head of Borrowdale, in the English Lake district, the rainfall is over 150 inches. In the Scottish Highlands amounts of over 100 inches are noted over considerable areas, with over 150 inches in Glen Quoich. The mountainous districts of western Ireland also have heavy rainfalls, reaching over 80 inches in a few places. The smallest amounts are found in eastern England, on the lee side of the islands, in the rain shadow. The isohyet of 20 inches, the lowest value on the map, is seen in the district around the mouth of the Thames. The increasing interest that is now being taken in the rainfalls of individual days, and of individual storms, would suggest the query why such maps were not included in the present publication. The answer is doubtless to be found in the fact that maps of this sort have been included in the annual volumes of *British Rainfall.*

Meteorologists are under a real debt of gratitude to the Royal Meteorological Society, under whose direction this most excellent Atlas was prepared, and to Dr. Mill, "to whose inspiration and guidance are mainly due the results and methods which are here presented." The cost of publication was defrayed out of the "British Rainfall Organization Fund" of the Society.

R. DeC. Ward

Recent Literature on Bird Migration

Alexander Wetmore. **The Migrations of Birds.** viii and 217 pp.; ills. Harvard University Press, Cambridge, Mass., 1926. $2.50. 8 x 5½ inches.

Horst Wachs. **Die Wanderungen der Vögel.** *Ergebnisse der Biologie,* Vol. 1, 1926, pp. 479–633.

A. Landsborough Thomson. **Problems of Bird-Migration.** xv and 350 pp.; maps, diagrs., bibliogrs., index. H. F. & G. Witherby, London, 1926. 18s. 9 x 6 inches.

William Rowan. **On Photoperiodism, Reproductive Periodicity, and the Annual Migrations of Birds and Certain Fishes,** *Proc. Boston Soc. of Nat. Hist.,* Vol. 38, 1925–1928, pp. 147–189.

Bird migration is a geographic subject partly because of the relative fixity of route and seasonal periodicity in the observed phenomena and still more because it is not improbable that secular climatic change may have had much to do with its origin. The four works here considered treat the subject both in historical aspect and in the light of contemporary observation and experiment. One of them (Thomson's) represents an effort to review the entire literature of the problem and to correlate a really vast quantity of data with the modern record in the fields of physiology, ecology, and earth history.

Wach's contribution furnishes one of the fullest summaries of the successive migration theories advanced in Europe and America, and of the bearing upon these—largely destructive—of the facts learned through the banding of migrant birds, a custom which has been the outstanding ornithological development of the past two or three decades. The precise information offered by the recovery of banded birds has naturally filled the place of earlier speculation as regards the speed, the calendar dates, and, to a lesser extent, the route of migrants. In other words, the "how" of migration seems in a fair way to be understood; the "why," however, remains almost as much of a mystery as before.

Rowan's short paper directly attacks the all-important matter of the origin and physiological control of the migratory impulse in the individual bird. His alleged factor, photoperiodism, is not a new idea, but he has supported it by experiments which indicate that a lengthening of the artificial day by electric lights, during the season when the solar day is shortening, has a direct and measurable effect upon the development of birds' gonads and a secondary effect upon the impulse to move to a different latitude.

Wetmore's book, while less important than Thomson's, is in a sense the most original of the three major works here discussed in that it is based largely upon the author's own extraordinarily wide field experience. Even his account of the prescientific period, and his discussion of the famous but now hackneyed historical examples that every young ornithologist must learn, are refreshing in the manner of telling. The only serious exception taken by the reviewer is Wetmore's out-and-out acceptance of the time-honored "sense of direction," without further elucidation of the term.

Thomson's voluminous book is divided into three parts relating, respectively, to an outline of the features of migration, studies with special reference to marked birds, and a statement and discussion of the main problems of migration. Throughout the work his citation of the pertinent literature is probably more exhaustive than that of any other author.

Many of the more recently learned details of migration such, for example, as the fact that certain species or groups of individual birds regularly "home" their way to winter haunts no less exact and restricted than their particular breeding sites or areas, may prove surprising to most geographers and biologists. Moreover, it is now certain that food, temperature, and all the other perfectly plain reasons for migration have, in point of fact, little or nothing to do with it. It is worth something to know what does *not* make birds migrate.

ROBERT CUSHMAN MURPHY

ESKIMO ARCHEOLOGY

THERKEL MATHIASSEN. **Archaeology of the Central Eskimos: I. Descriptive Part,** vi and 327 pp.; maps, diagrs., ills.; **II. The Thule Culture and Its Position Within the Eskimo Culture,** 208 pp.; map, diagrs., ills. (Report of the Fifth Thule Expedition 1921–24, the Danish Expedition to Arctic North America in charge of Knud Rasmussen, Ph.D., Vol. 4.) Copenhagen, 1927. 11 x 7 inches.

This work auspiciously opens the series of scientific reports that will present the results of Knud Rasmussen's Fifth Thule Expedition to the Arctic. Rasmussen himself has already published the general history of his expedition in a fascinating volume, "Across Arctic America" (reviewed by W. Thalbitzer in the *Geogr. Rev.*, Vol. 17, 1927, pp. 341–342). Mathiassen now follows with the first of the two archeological reports. No one who has experienced the peculiar difficulties of archeological work in the frozen soil of the Arctic will fail to admire the extraordinary enthusiasm of the author and his colleagues in investigating so many sites, in places so widely separated as Repulse Bay and Southampton Island in Hudson Bay, Ponds Inlet and Button Point at the north end of Baffin Island, and King William Island near the magnetic pole; and his admiration will increase as he remarks the meticulous care with which they excavated each ruin. The same industry and care are visible on every page of this report, which opens up a new vista into Eskimo prehistory. Mathiassen presents his material logically and with great fullness, separates clearly the theoretical conclusions from the ascertained facts, and illustrates all the more important specimens. The reader would prefer legends against each plate to save much time in searching for descriptions of the specimens through the text; but this is a small defect in a well-balanced and carefully presented account that runs into several hundred pages.

The work is divided into two parts. The first, which describes the ruins and the specimens found in them, calls for little comment. The presence of a few specimens of nephrite (jade) on the west coast of Hudson Bay and on Baffin Island may conceivably indicate an early trade connection with northern Alaska, since geologists have not recorded this mineral east of the Rocky Mountains; more probably, however, it exists somewhere on Baffin Island, which is still largely unexplored. The reviewer's theory (*Geogr. Rev.*, Vol. 13, 1923, pp. 547 f.) that copper was unknown to the Eskimos of the ancient Thule culture but was acquired first by the Eskimos who migrated later into the region of Coronation Gulf is disproved not only by the presence of some copper objects in the ruins excavated by the expedition but also by the recent discovery of a harpoon head with copper blade in an old stone house of the Thule period within the Coronation Gulf area itself. Copper seems to have been rare at this period, however; possibly because the Eskimos had not yet discovered the principal outcrop of the metal near the Coppermine River.

After describing the archeological remains on Southampton Island Mathiassen gives an interesting account of its former inhabitants, the Sadlermiut, gleaned from some mainland Eskimos who had come into contact with the last survivors of the tribe; and he confirms Munn's statement (*Geogr. Journ.*, Vol. 54, 1919, p. 54) that an infectious disease introduced by a trading vessel, not starvation, was responsible for their extinction.

In Part II Mathiassen analyzes his material and discusses the distribution of the specimens throughout Eskimo territory. His classification of harpoon heads, although not quite complete since it scarcely covers all the multifarious types known in the western Arctic, is far in advance of those proposed by earlier writers; and his clear definition of the elements contained in the ancient Thule culture, as contrasted with the modern culture in the eastern Arctic, provides a new and safe groundwork for all future researches into Eskimo prehistory. To the elements attributed to the Thule culture one feels inclined to add the sealing net of baleen or rawhide; for, although he found no trace of it in Hudson Bay, it seems to have been known in Greenland in pre-European times, and a mesh gauge for its manufacture has been discovered in an ancient ruin at Wales, Alaska. The fish net, on the other hand, is now known to have reached Bering Strait at the same time as iron, about 1700, and to have spread thence to the Mackenzie River delta; its absence from older remains in Alaska strongly favors the probability of its introduction by Europeans into the Hudson Bay region—unless, indeed, the eastern natives acquired it earlier from the Indians of the interior.

Incidentally, it may be observed that not all the ruins on Barter Island, in northern Alaska, belonged to the stone age, as Mathiassen states (Part II, p. 58). In 1914 the reviewer carefully excavated fifteen house sites on the west end of the island and nearly sixty house sites, tent sites, and graves on the east end; two houses and several of the graves contained iron; and none of the ruins were older, apparently, than 300 years, for all the sealing harpoon heads had closed sockets, like those in use during the nineteenth century, whereas in Bering Strait the older, open-socketed types were still common at the introduction of iron. Mathiassen's theory, however, that more ancient ruins in the western Arctic might show a greater resemblance to the Thule remains of the Hudson Bay region has been confirmed by recent researches in Bering Strait; and it is difficult to refute his argument that the Thule culture as a whole originated in the west.

Concerning the earliest home of the Eskimo Mathiassen cautiously expresses no opinion, rightly believing that the question cannot be settled without further archeological investigations in Alaska. Investigations are necessary, also, in the Hudson Strait region and in Labrador, to unravel the mysterious Cape Dorset culture, which, even as represented in the remains that he excavated at Button Point, stands in striking contrast to the Thule and later cultures at Ponds Inlet in the same region. There seems to have been a mutual borrowing of culture elements between the Beothuk and the people of the Cape Dorset culture; and, as the former were isolated in Newfoundland from 1600 A. D. onward, this borrowing must have occurred at least a century and probably several centuries before that date. If, then, the Cape Dorset culture is but a locally stamped phase of the Thule, as Mathiassen thinks, it must be quite an ancient variation to react on the Beothuk, to spread from Labrador to Ellesmere Island, and to leave its marks even in King William Land and Greenland. May it not be possible, in view of its limitation to the eastern Arctic, its wide diffusion in that area, its marked differences from the Thule stage of Eskimo culture, and its links with the Beothuk, that it sprang from an earlier Eskimo source still unknown and that it failed to survive in conflict with the more advanced cultures of Thule and post-Thule times? Such a theory, of course, still further complicates the problem of Eskimo prehistory; but, after all, that prehistory is to be measured not by centuries only but by millenniums.

D. Jenness

The Eskimos of Coronation Gulf

Diamond Jenness. **The People of the Twilight.** xii and 247 pp.; maps, ills. The Macmillan Co., New York, 1928. $3.00. 9 x 6 inches.

A "charming narrative," says Dr. Nansen in his preface; and the expression is just. This Odyssey of the wandering life of the primitive Eskimos of Coronation Gulf is told with deep sympathy and great artistry. As a member of the Canadian Arctic Expedition Mr. Jenness spent two years among them and, as an adopted son of the couple Ikpuck and Icehouse, lived "from autumn to autumn" as one of themselves. His scientific reports have been unusually interesting, but the present work makes still more vivid the picture of a people close bound to its environment in all its thoughts and deeds.

"In winter, when the land lay bare and silent beneath the snow, when the caribou had migrated south, when the twilight hours were brief and the nights long, the natives had banded together into tribes, and tribe combined with tribe to wrest a precarious livelihood from the frozen sea by united effort. Food had been common to all, and their snow-houses had adjoined each other so closely that the families seemed absorbed in the group. With the returning sun and lengthening days nature had recalled its life; the seals had appeared on top of the ice, the caribou had come northward again, and the tribes of Eskimos had broken up into little bands. For a time they had lingered on the ice to hunt more seals; then, turning landward, they had pursued the caribou over the snow-covered hills and plains. Now the snow was vanishing, the caribou had scattered, and fish alone provided a sure livelihood until midsummer. So my party, like many another throughout the country, was dividing into its constituent households, each of which now toiled for itself alone. The tribe no longer existed; society had dissolved into its first element, the family."

Such rigorous control implies marginal existence. There is always the threat of starvation, when the lights fail to "burn brightly again in every home" and there is no "dining sumptuously on dried trout and frozen salmon." A balance so precarious under nature must be profoundly disturbed by the entry of an alien civilization, and that entry has commenced for the "Twilight Land": what will its outcome be? On this query Mr. Jenness concludes his moving story.

THE GREAT NOMAD CONQUEROR

HAROLD LAMB. **Genghis Khan: The Emperor of All Men.** viii and 270 pp.; maps, ills., bibliogr., index. Robert M. McBride & Co., New York, 1927. $3.50. 9 x 6 inches.

Theodore Roosevelt, in his Foreword to Jeremiah Curtin's "The Mongols, A History," protests vigorously and justly against the prevailing ignorance regarding what he calls "the most stupendous fact of the [thirteenth] century—the rise of Genghis Khan and the spread of the Mongol power from the Yellow Sea to the Adriatic and the Persian Gulf."

Asia has always been fertile in men of the highest genius. Among these have been Ch'in Shih-huang, the first founder of the Chinese Empire, in the third century before Christ; Attila, the "Scourge of God," whose forbears if not he himself were Asiatics; T'ang T'ai-tsung, the second founder of the Chinese Empire, in the seventh century of our era, beyond question the most powerful ruler of his day; and Tamerlane, the mighty "Earth Shaker," to name but a few of the greatest. But greater than any, both in the difficulties he overcame and in the results he achieved in his own lifetime, was the superman whose life story forms the theme of Mr. Lamb's book. As the author says,

"And here we are face to face with the mystery that surrounds Genghis Khan. A nomad, a hunter and herder of beasts, outgeneraled the powers of three empires; a barbarian who had never seen a city and did not know the use of writing drew up a code for fifty peoples. . . . Of necessity we must turn to Alexander of Macedon . . . to find a conquering genius the equal of Genghis Khan. . . Both died in the full tide of victory, and their names survive in the legends of Asia to-day."

Mr. Lamb's book is symptomatic of the desire to know more about Asia which has been growing steadily during recent years. That the author, perhaps best known hitherto as a purveyor of excellent historical tales with an Asiatic setting, is blessed with a happy knack of description, the following will show:

"Life did not matter very much in the Gobi. Lofty plateaus, windswept, lying close to the clouds. Reed bordered lakes, visited by migratory winged creatures on their way to the northern tundras. Huge Lake Baïkul visited by all the demons of the upper air. In the clear nights of mid-winter, the flare of the northern lights rising and falling above the horizon.

"Children of this corner of the northern Gobi were not hardened to suffering; they were born to it. After they were weaned from their mother's milk to mare's milk they were expected to manage for themselves."

Or take the following, in regard to the Mongols' amazing march westward:

"Entering the western ranges beyond the Gate of the Winds, the warriors cut down trees, hewing out massive timbers to be used in bridging the gorges. The ponies dug up moss and dry grass with their hoofs from under the snow. The hunters went afield for game. Forging ahead in the utter cold of high Asia, a quarter million men endured hardships that would have put a modern division into hospital. The Mongols did not mind it particularly. Wrapped up in their sheepskins and leather, they could sleep under drifting snow; at need, the round, heavy *yurts* [hemispherical felt tents] warmed them. When food failed, they opened a vein in a horse, drank a small quantity of blood and closed the vein."

Mr. Lamb's book, of interest from many points of view, is not least so from that of human geography. In the course of his story, he gives us vivid pictures of that type of culture which from before the dawn of history has characterized the steppe regions of the Old World. That culture was in many ways a direct response to the demands of an almost unimaginably severe environment, and it seems to have taken on definite and final form somewhere around the close of the second millennium before the Christian era, with the development of the "horse-archer" type of warrior. It was not long thereafter till the civilized portions of the Old World began to be tormented by the onslaughts of the fierce riders of Central Asia.

But the recurrent outbursts of raiding and turmoil and bloodshed meant among other things the trampling down of the national barriers that have always tended to erect themselves in the way of free travel across the breadth of Asia. This has happened time and again. The first well authenticated journey under such circumstances appears to have been that of the Chinese explorer and diplomatic agent, Chang Ch'ien, in the second century before Christ; although we might perhaps be able to point to an earlier instance in the travels of Aristeas of Proconnesus (seventh century before Christ?), had we but his lost poem, the *Arimaspeia*. The transcontinental journeys of John of Plano Carpini, of William of Rubruk, of the Polos, of John of Monte Corvino, of Ibn Batuta, and many lesser lights of the period could never have taken place but for the conquests of Genghis Khan.

The net result of such journeys was to reawaken Occidental interest in the lands of silk and spice, just at the time when the Ottoman Turks, themselves set in motion by the impact of the Mongol incursion, were about to erect anew the barriers in the way of free intercourse between East and West. As is well known, Columbus sought not a New World but an alternative route to the realm of the Grand Khan. This is still another point of view from which a study of the life and acts of the great Mongol leader and the consequences which flowed from them is indispensable to a right understanding of historical geography.

Mr. Lamb's illustrations are well chosen and really illustrative, while his book has a useful bibliography and a first-class index. It is a compact, convenient, and very readable account of the life of one of the world's greatest geniuses.

C. W. Bishop

Memorial to an Eminent Russian Geographer

A. A. Dostoïevsky, edit. **Peter Petrovitsh Semenov-Tian-Shansky,** sa vie et son oeuvre. 265 pp.; ills., bibliogr. Société Russe de Géographie, Leningrad, 928. 11 x 7½ inches. [In Russian.]

In this special publication of the Russian Geographical Society a number of Russian scientists, mostly former collaborators, here give an appreciation of the eminent and versatile scientist, statesman, and humanitarian, Peter Semenov-Tian-Shansky, who died February 26, 1914, at the age of 87. The scope, scale, and fundamentality of his work, together with his efficiency and the fine human qualities of his personality, are dominant notes of the volume. In 1849 the young Semenov was elected a member of the recently founded Russian Geographical Society and appointed its librarian, his career as a geographer thus being determined. In various capacities he was associated with the Society to the end of his life, from 1860 to 1873 acting as president of the section of physical geography and from this date as vice-president of the Society. His first geographical work was the description of New California, New Mexico, and Oregon in physical, political, and ethnographical relations, published in 1851. Among his capital works are his translation of Karl Ritter's "Asia," in nine volumes with extensive supplements bringing it up to date; a geographical statistical dictionary of the Russian Empire, published under his direction, the greater number of the important articles being written by him; "The History of the Fiftieth Anniversary of Activity of the Russian Geographical Society 1845–1895," in three volumes, with the collaboration of A. A. Dostoïevsky—a work, as Schokalsky says, that "is the real monument to the activity of the Society and the geographical study of Russia." A long series of the author's geographical works have been published in the periodicals of that Society and in special publications elsewhere.

As a geographer and explorer, Semenov-Tian-Shansky obtained his name from his expedition to Tian Shan in 1856–1857, the first successful expedition to this difficult region. Its success was due to thorough preparation and organization and to a scientific foresight possessed by him also in other domains. While directing the Russian Geographical Society he at the same time inspired other extensive geographical explorations of northeastern and central Asia—those of Prjevalski, Potanin, Grum Grzhimailo, Mushketov, Koslov, Obruchev, Bogdanovich and others.

Besides attaining scientific distinction he was an eminent statesman who gained a name in the public life of Russia as one of the workers for the freedom of Russian peasants from serfdom. For many years he organized the collection of Russian official statistics including the first Russian census, of the necessity of which he was conscious and labored to make the government recognize its importance, for more than thirty years.

He was the recipient of many honors. In 1906 the addition of Tian Shan to his name of Semenov was granted, not only to him but to his descendants. A number of geographical features have been named for him, mostly in Central Asia but also in Caucasus, Spitsbergen, Kara Sea, as well as Semenov Mountain in Alaska on the right shore of the Yukon. About a hundred families, genera and species of mammals, birds, fish, insects, plants, fossils bear the name of Semenov—for he was botanist, entomologist and geologist as well as geographer. The Russian Geographical Society established a medal bearing his name; he himself received several medals and was on the honorable list of many scientific institutions at home and abroad, among them the American Geographical Society of which he was elected a corresponding member in 1896.

THE LINE OF DEMARCATION, 1493

PAUL GOTTSCHALK. **The Earliest Diplomatic Documents on America: The Papal Bulls of 1493 and the Treaty of Tordesillas Reproduced and Translated with Historical Introduction and Explanatory Notes.** 91 pp.; plates, bibliogr. Paul Gottschalk, Berlin, 1927. $66.50. 12 x 15¾ inches.

Paul Gottschalk, Berlin bookseller and publisher, has done a useful piece of work. The bulls of Alexander VI, which divided the earth's surface between Spain and Portugal, and the Treaty of Tordesillas, which established the famous demarcation line as running from pole to pole and passing through a point 370 leagues east of the Cape Verde Islands, are, as Gottschalk says, "among the most important diplomatic documents ever issued." To a very large extent they are "responsible for the fact that in certain parts of America Spanish is the spoken language while in others it is Portuguese." Besides their geographical interest they occupy an important place in the development of international law.

In the sumptuously printed and richly bound volume before us the photographic reproductions of the original documents, the transliterations, and the bibliography will be of unquestioned value to scholars. It could be wished, however, that Mr. Gottschalk's English were clearer, not only in the translations, where obscurity may be excused on the ground of the obscurity of the original, but in the explantory text and discussions of controversial matters. A work of this importance and costliness ought to have been carefully revised and parts of it even rewritten by someone thoroughly competent in the art of English expression. Furthermore, we fail to see the point of the reprints from Dr. E. L. Stevenson's "Maps Illustrating Early Discovery and Exploration in America, 1502–1530"—at least we find it difficult to understand why these reprints are given in the form that Gottschalk has adopted. The three maps are cut up into no less than fifty-one separate sections, some of which show nothing but ocean and margin. As no reduced facsimiles of the three original sheets are supplied, it is impossible to gain an idea of the maps as a whole.

French Geographical Books of the Sixteenth Century

Geoffroy Atkinson. **La littérature géographique française de la Renaissance: Répertoire bibliographique.** 565 pp.; ills., index. August Picard, Paris, 1927.

Before the close of the fifteenth century the average Occidental's idea of the world beyond the bounds of Europe was vague and blurry—like the image seen through an unfocused field glass. Exploration into remote regions alone did not suffice to bring clarity to his view. The Norsemen reached America in the tenth century, Marco Polo wandered through the greater part of Asia in the thirteenth, and missionaries penetrated China, India, and Abyssinia in the fourteenth and fifteenth; but what they observed did not dispel the mists of general geographic ignorance and confusion. It was the introduction of the printing press which brought the outside world into focus for European eyes and enabled the ordinary reader to see clearly lands and peoples beyond his near horizon.

That printed books of travel dealing with exotic regions became very popular in France in the sixteenth century is shown by the admirable publication under review. Careful bibliographic descriptions are here given of 524 works, all of which were published in French between 1480 and 1610 and each of which deals for the major part with non-European countries. Professor Atkinson has based his study on the direct examination of the books themselves in the libraries of France and gives useful indications of where copies may be found. His volume is carefully worked out and thoroughly indexed. An interesting feature is a series of 300 reduced photographic reproductions of title pages. The book should prove an indispensable tool for students of the spread of geographical knowledge during the great Age of Discovery.

A New York State Park Handbook

A. K. Lobeck. **A Popular Guide to the Geology and Physiography of Allegany State Park.** 288 pp.; maps, diagrs., ills., bibliogr., index. (New York State Museum Handbook 1.) Albany, 1927.

Allegany State Park is an area of about 100 square miles lying in western New York, within the great bend of the Allegheny River. Together with the Allegheny National Forest of Pennsylvania, which it borders on the north, it comprises a region well suited to the study and preservation of natural life. It is largely a forest wilderness forming part of the northeastern hardwood belt, though there are some farms in the main valleys. Situated in the submaturely dissected Allegheny Plateau, it is physiographically and geologically a comparatively simple area. Professor Lobeck's method of dealing with his material is one which hitherto has been somewhat rarely used in this country. In addition to giving a description of the park he has undertaken to present to the reader the underlying principles of physical geography. To do this he has divided his work into chapters dealing with the general geology of the region, the rivers and valleys of the park, and the ice age in the park; and to each of these chapters he has added a supplementary one dealing with the broader aspect of the topic. Among his maps is one (p. 120) showing the terminal moraine in Pennsylvania, compiled by W. C. Alden and giving information additional to the Pennsylvania Geological Survey map published in 1881, and also a physiographic diagram of the same nature as the author's earlier ones of Europe and the United States. "The Flora of the Allegany State Park Region," by H. D. House and W. P. Alexander, and "The Amphibians and Reptiles of Allegany State Park," by S. C. Bishop, comprise respectively the second and third handbooks of the New York State Museum.

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The American Geographical Society is the oldest geographical society in the United States. When it was founded, in 1852, there were but twelve similar societies in the world. Now it exchanges publications with more than four hundred scientific associations. The Society publishes the *Geographical Review*, a quarterly magazine issued in January, April, July, and October, and a *Research Series* of comprehensive scope. It has also a large and growing library—one of the most important geographical libraries of the world; thousands of maps and charts; and a remarkable collection of atlases of the sixteenth, seventeenth and eighteenth centuries.

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GEOGRAPHICAL REVIEW

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OUR CONTRIBUTORS

Mr. Putnam is a member of the publishing house of G. P. Putnam's Sons. His avocation is exploration. In 1926 he organized and conducted the American Museum Expedition to Greenland, and he has been associated in an advisory capacity with many recent expeditions and explorations. He is the author of "The Southland of North America" (1913) and "In the Oregon Country" (1915).

Professor Gould is a member of the Department of Geology of the University of Michigan, of which he is a graduate. In 1926 he was Assistant Director of the First Greenland Expedition of the University of Michigan led by Professor W. H. Hobbs.

Mr. Hanson is an engineer. He has recently returned from Iceland, where he made a study of industrial possibilities. To the July, 1926, number of the *Geographical Review* he contributed the paper "Out-of-the-World Villages of Atacama."

Mr. Bennett is attached to the U. S. Bureau of Soils and Chemistry. The following works are indicative of the special sphere of his activities: "The Soils and Agriculture of the Southern States" (1921), dealing with the region south of a line drawn from Delaware to Kansas; "Some Geographic Aspects of Western Ecuador," "Agriculture in Central America" in *Annals Assn. of Amer. Geogrs.* September, 1925 and June, 1926, respectively; and, with others, "Possibilities for Para Rubber Production in Northern Tropical America," *U. S. Dept. of Commerce, Trade Promotion Ser. No. 40*, 1926, a report including some interesting soils maps. Mr. Bennett is now prosecuting studies in soil erosion in the United States.

Mr. von der Osten prosecuted his Oriental studies at the University of Berlin, concentrating especially upon Hittitology. In 1925 he received a traveling Carnegie fellowship through New York University; and in 1926 Professor James H. Breasted, Director of the Oriental Institute at the University of Chicago, arranged for the additional support under which Mr. von der Osten in the summer of 1926 made his first exploratory trip to the ancient Hittite country of Asia Minor. Subsequently he was made a member of the Oriental Institute staff and Field Director of the Hittite Expedition whose second season of work has just been completed.

Dr. Ahlmann is Docent in geography at the University of Upsala. During later years he has devoted himself both to physical and human geography. His work in physical geography includes special geomorphological and glaciological studies in Norway. He has, among other geographical journeys, made three in Italy; and during the winter of 1926–1927 he spent three months in Cyrenaica and Tripolitania. The results of his work have been published chiefly in English and French in the *Geografiska Annaler* and in Swedish in *Ymer*.

Mr. Marmer has for many years been connected with the Division of Tides and Currents of the U. S. Coast and Geodetic Survey and is now serving as Assistant Chief of the Division. To the *Geographical Review* he has contributed several papers. He is the author of "The Tide" (1926), and of "Tides and Currents in New York Harbor," "Coastal Currents Along the Pacific Coast of the United States," and "Tidal Datum Planes," *U. S. Coast and Geodetic Survey Special Publs.*, No. 111, 1925; No. 121, 1926; No. 135, 1927, respectively.

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THE
GEOGRAPHICAL REVIEW

VOL. XVIII JANUARY, 1928 No. 1

THE PUTNAM BAFFIN ISLAND EXPEDITION

George Palmer Putnam

[With separate map, Pl. I, facing p. 40]

FIG. 1—A great berg in Hudson Strait.

> I present you heere neither with Jason's voyage to Colcos, nor the Golden Fleece as yet, but with the best of my endeavours to the North-West, which we poore Discoverers are so jeered about . . .
>
> My pen and selfe now is growne weary; and, hoping some other brave Spirit will enter the Lists and attempt the Enterprize, I rest—*Luke Foxe in the narrative "North-West Fox" of his voyage of 1631.*

ALMOST three centuries have passed since Luke Foxe returning from his voyage in search of the Northwest Passage wrote the above adjuration, and many have been the brave spirits who entered the lists. The map of Arctic Canada is the witness of their heroic adventuring. Today, however, the "voyage to Colchis" has resolved itself into the routine annual patrol of the Canadian Department of the Interior, while Hudson's Bay Company steamers annually carry away the Golden Fleece!

But not quite all the romance of the unknown has departed. This past summer the Putnam Baffin Island Expedition enjoyed the unique experience of sailing for some 500 miles on a course the charts show fifty miles and more removed from salt water. In consequence an area larger than the State of Connecticut has, cartographically speaking, been sunk beneath the surface of Foxe Basin; and Baffin

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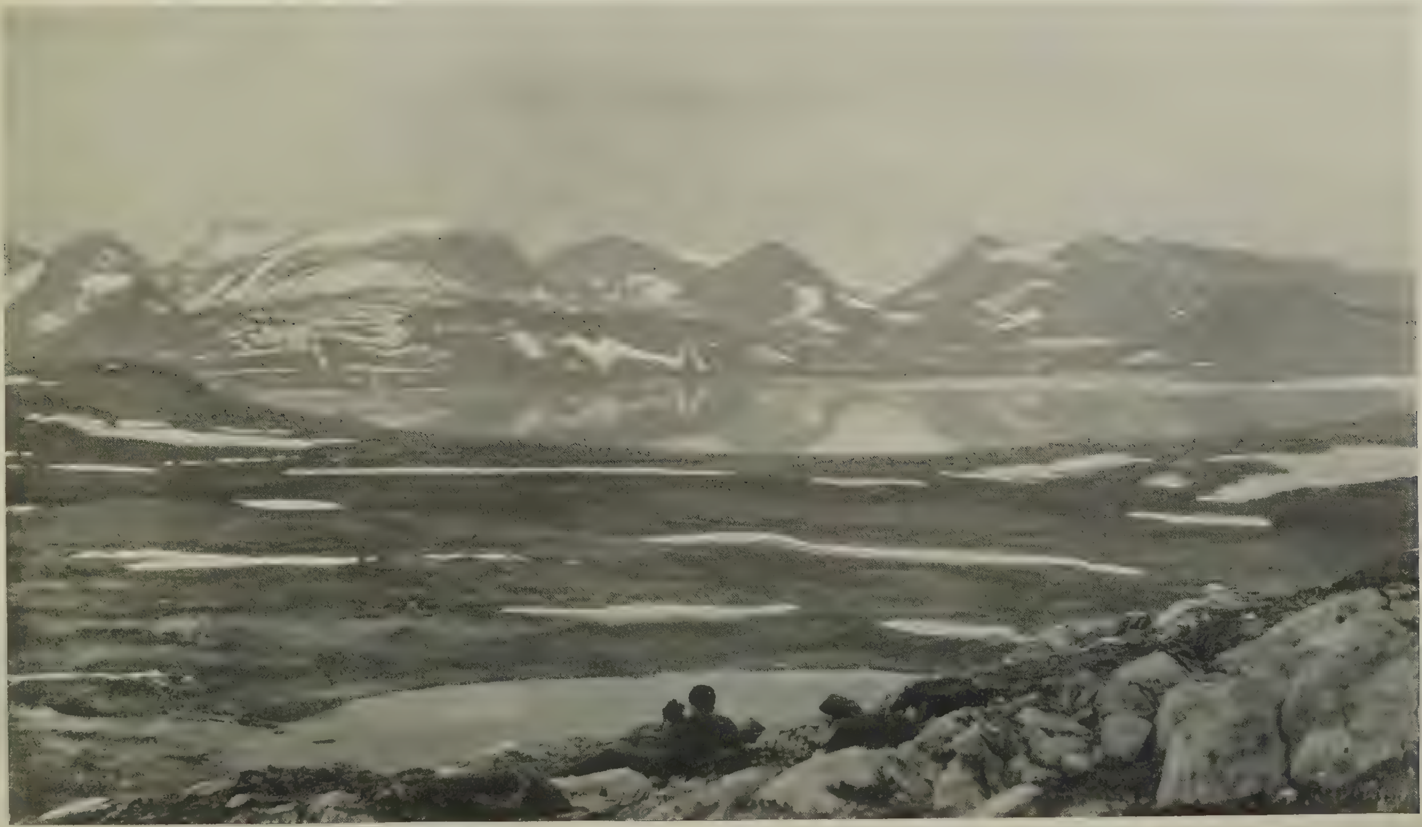

FIG. 2—A view of Kangardluarsuk Fiord, in the Torngats region of northern Labrador (see Fig. 26).

Island, the great island accredited by the Canadian government with some 211,000 square miles of area, has been reduced by something over 5000 square miles. While the other coasts of Baffin Island have been visited recently, our knowledge of this portion of the southwest coast has remained virtually as it was established by Foxe, and the charting of it has stood unchallenged as originally laid down a hundred years ago by Parry from the data of Foxe's voyage.

In itself the newly traced shore line is geographically interesting. From the Expedition's camp at longitude 75° 15′ W. one could look miles inland to a horizon almost as straight as that over the sea, its monotony broken only by erratic boulders deposited by the retreating ice of earlier ages. In the deceptive light of these high latitudes where mirages are forever playing visual pranks these dark rocks seen from afar loom up like veritable Gibraltars only to shrink on approach to insignificant fragments in a sea of mud.

A wilderness of more dead monotony, a landscape of more utter desolation it is difficult to picture. In all that part of Foxe Land visited there is only one distinctive landmark—the great limestone highland that rises from the soggy flats of Blue Goose Prairie at the southeastern extremity of Foxe Basin. The contrast is startling. In sharpness of profile and general character this mesa looks as if it might have been bodily transported from the Colorado Desert and dropped into its present alien environment. It is a strange country.

OBJECTIVES AND PERSONNEL OF THE EXPEDITION

The main objective of the Expedition was geographical exploration of this virgin territory of Baffin Island—work in the charge of Professor Laurence M. Gould of the University of Michigan, assisted by George Weymouth of Philadelphia, Monroe G. Barnard of New York, and John A. Pope of Detroit. The other general personnel of the party included Robert E. Peary and Wallace R. Hawkins, engineer and assistant; Dr. Peter Heinbecker, surgeon; Edward Manley, radio director; Maurice Kellerman, motion picture photographer; Junius B. Bird, botanist; and two junior members, David Binney Putnam and Deric Nusbaum.

Collateral work, secondary to the main purpose, was undertaken for four scientific institutions: Donald A. Cadzow, anthropologist, representing the Museum of the American Indian, Heye Foundation, collected ethnological and archeological specimens and data; Dr. Peter Heinbecker, Fellow of the National Research Council in Medicine, conducted various medical investigations;[1] Fred Limekiller, taxidermist, did zoölogical collecting for the American Museum of Natural History; and plankton collections for the Buffalo Society of Natural Sciences were secured.

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[1] Problems taken up by Dr. Heinbecker included a study of certain starvation symptoms among the Eskimo and the sensitivity of these isolated people to certain toxins. All the natives now resident on the west coast of Baffin Island and many of those along the north shore of Hudson Strait, totaling some hundred and fifty, were blood-grouped.

The author was director of the Expedition, and Captain Robert A. Bartlett was master of the Expedition's vessel, the schooner *Morrissey*. The *Morrissey* herself, a two-masted Newfoundland fishing schooner of the older type, engined and thoroughly equipped[2] for summer work in the Arctic, gave excellent service despite rough usage and sundry mishaps.

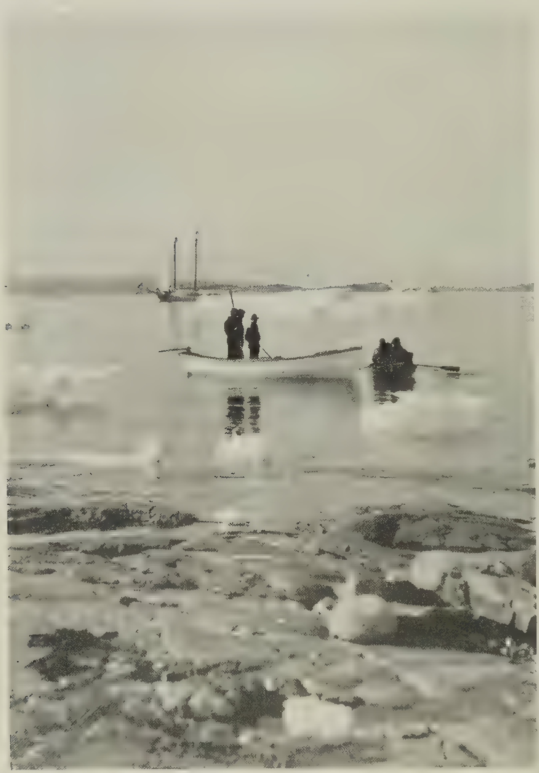

FIG. 3—Landing on Sculpin Island, Labrador.

We sailed from Rye, N.Y., on June 12, 1927. Brigus, Newfoundland, was reached on June 20, and departure made thence two days later. Unusually far south along the Labrador coast we encountered ice and evidences of a late season. Climatic conditions throughout the summer indeed were adverse to our plans and progress. From the information of natives and traders familiar with other years, we judged the weather unusually bad. Out of sixty days spent within the entrance of Hudson Strait, only eight were genuinely fair throughout. For thirty-two days fog was recorded as present all or most of the daylight hours, often with rain. On two occasions the sun was not visible for six days in succession; and fog, rain, and gales prevailed in about equal proportions. The annual patrol of the Canadian Arctic Archipelago confirms the exceptional weather.

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[2] Two members of the Council of the American Geographical Society contributed to the Expedition—James B. Ford and Frederic C. Walcott. Other contributors were W. F. Kenny of New York, Gustavus D. Pope of Detroit, and George Grey Barnard of New York; the Museum of the American Indian, Heye Foundation; and the Buffalo Society of Natural Sciences. The balance of the budget was underwritten by the Director. It was the generous gift from Harrison Williams to the preceding season's Greenland Expedition which made possible much of the equipment utilized on this undertaking.

Special appreciation is due the Canadian authorities, who supplied promptly the requisite permits, primarily through the office of O. S. Finnie, Director of the Northwest Territories; to the U. S. Coast and Geodetic Survey for loaning valuable scientific paraphernalia; to the Bureau of Fisheries for net equipment; and to the School of Surveying of the American Geographical Society for instruments.

> The unusual weather conditions referred to were continual fogs—there being only a few fine days in the fifty-one occupied by the voyage—and the prevalence of easterly winds and gales instead of northwest winds which are usual during the summer. The fogs made navigation very difficult, especially in that part of the cruise in which the ship was north of the magnetic pole.[3]

From Cape Harrison north the heavy pack for the most part hung close to the shore, in vast drifting fields. We made our way chiefly well in by the land, working along through loose pans and leads of open water, dodging behind islands, and "cross cutting" through "tickles." North bound we visited briefly the settlements of Mokkovik, Hopedale, and Nain; stopped at the island Turnavik; and spent a day on Sculpin Island some twenty miles from Nain.

RUINS NEAR NAIN

On Sculpin and other islands in the vicinity of Nain exist stone house ruins reputed to be of Norse origin, to which fresh attention is periodically directed. Ours was but a cursory examination, made during one strenuous twenty-four hours of daylight. Sculpin Island is some two miles by one; just to the east and accessible from it at low tide is an islet possibly a quarter of the size. Both islands are bare and rocky, stunted bushes and coarse grass struggling for existence in sheltered depressions. The highest hills of glacier-polished rock rise perhaps 300 feet.

The ruins themselves are on a small, rocky peninsula of the smaller island, the group containing eleven major structures. Near by is a protected landing place for small craft, with some indication of a partially artificial breakwater. The maximum height of the house walls still standing is about three feet, and the dimensions of a typical larger structure, oblong in shape, are approximately 12 by 18 feet. The chief walls, apparently averaging about 18 inches in thickness, are constructed of flat, natural stones. In at least one building a clearly defined doorway remains, with a rectangular entrance passage beyond it. Several such outer-entrance approaches are evident. Except for their rectangular feature they resemble the entrance tunnels of modern Eskimo winter houses in Greenland.

Mr. Hettisch, the Moravian missionary at Nain, told us that the Eskimo name his parishioners use for these relics signifies "the houses built by strange people." Apparently they know nothing of their origin. Dr. Gould constructed a map of the group, with measurements of individual structures. Careful excavation in one house brought to light nothing. Thorough-going archeological study alone can determine with any definitude the comparative antiquity of the ruins and their possible historical significance.

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[3] 1927 Expedition Completes Season's Work in Eastern Arctic, *Nat. Resources Canada*, Vol. 6, 1927, No. 10, p. 1.

Unrecorded Lakes in Northern Labrador

Cape Mugford we passed during the afternoon of July 1, a region of gorgeous scenery comparable with Norway's best. Outside the Cape itself, with its culminating pinnacle of the "Bishop's Mitre" 3000 feet above the sea, stand the islands of Nanuktut and Ogualik, shaggy masses of sheer rock; and inland a deep-indented palisaded fiord pierces straight into the heart of the mountains. It was an alluring scene on that calm sunlit evening; but vastly different three months later when, homeward bound, we buffeted our way around the black crags in the teeth of a southeast gale that stood the little *Morrissey* on her beam ends.

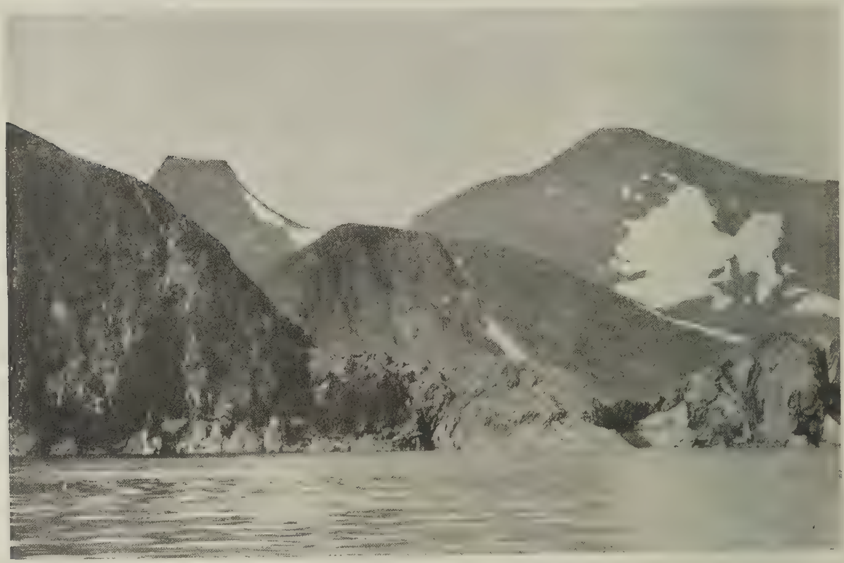

Fig. 4—Labrador coast near Cape Mugford.

From Saglek Bay the ice clung close to land. For three days we were in and out of the pack and by July 4, thanks to a northeast gale, were well beset. That night the pressure of exceptionally heavy pans put our propeller and shaft out of commission. From the 5th to the 9th a battle ensued between the crippled *Morrissey* and the ice. Continuing northeast gales cemented the pack together and shoved us slowly southward. Once we were almost off Cape Chidley at the mouth of the Strait. When we got out of the pack, off the

"Four Peaks" in latitude 59° 40', we had drifted[4] perhaps fifty miles south, always with the mountainous shore line in sight. Our escape was largely due to the excellent assistance of the motor whaleboat and launch, lashed astern and shoving when there came any chance of progress.

On a beach in a bight of Kangardluarsuk Bay, Captain Bartlett beached the vessel, and our spare propeller and shaft were installed in a rather strenuous job, the engineering credit for which is largely due Robert Peary. While repairs were in progress the adjacent territory was reconnoitered. Our anchorage lay just at the base of the mountains called on the chart the "Four Peaks" supposed to be the culminating heights of the Torngats.[5] From the bay we penetrated inland to an unrecorded tidewater lake,[6] some fifteen miles long, averaging over two miles in width, and possessed of a rugged Alpine beauty truly spectacular. Connecting it with a second lake

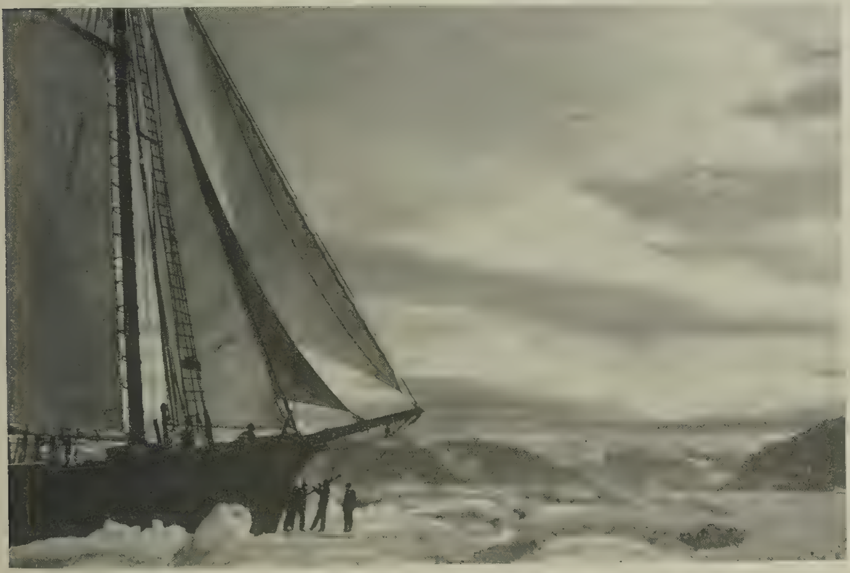

FIG. 5—The *Morrissey* in the ice off the Four Peaks region, northern Labrador.

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[4] C. O. Iselin, in "A Study of the Northern Part of the Labrador Current," gives an average figure for the velocity of the Labrador Current along the whole length of the coast as from 10 to 14 miles a day (*Bull. Natl. Research Council No. 61*, Washington, 1927, pp. 217–222). It varies considerably in place and season. Our own experience when homeward bound in September in the face of persistent southerly winds substantiated the contention of men familiar with the northern Labrador coast that after a period of such wind the current becomes practically non-existent until a shift in wind direction occurs.

[5] See R. H. Woodworth: Notes on the Torngat Region of Northern Labrador, *Geogr. Rev.*, Vol. 17, 1927, pp. 632–642.

[6] To these lakes and a limited number of the other hitherto unnamed geographical features explored by the Expedition tentative names were bestowed, subject to acceptance by the Newfoundland and Canadian governments. The suggestions have been submitted to the appropriate authorities who will also, of course, receive such of the Expedition's data as may be serviceable to them.

farther westward, is a freakish gorge over a mile long, narrowing to fifty yards in width, with precipitous walls (see Figs. 9 and 26). Through the 120 foot drop at its westerly end the overflow of the upper lake plunges, in a series of falls, to the semi-salt waters of its neighbor.

THE SOUTHERN SHORE OF BAFFIN ISLAND

On July 17 we passed into Hudson Strait, close to Resolution Island on the north shore, and late on the 19th anchored in Ashe Inlet on Big Island, some 300 miles from the entrance, chiefly to obtain water. The "furious overfall" of Davis[7] near Resolution, where seven-knot tides create veritable rapids, fortunately was negotiated on a clear, calm afternoon, with no pack about. The dangers of encountering heavy ice while passing through that belt of amazing whirlpools were evident enough even as it was.[8]

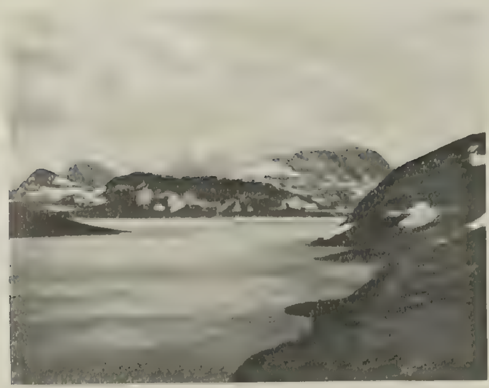

FIG. 6

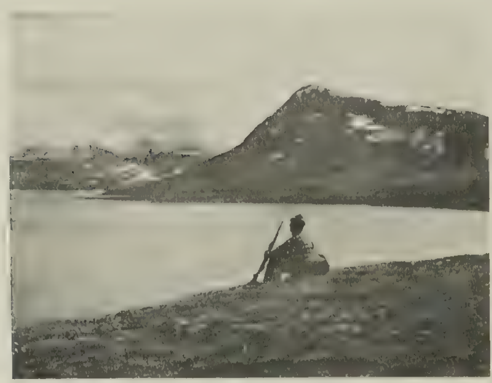

FIG. 7

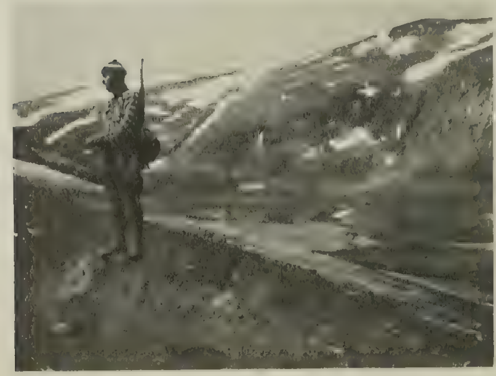

FIG. 8

FIGS. 6, 7, 8—In the Four Peaks country of northern Labrador. Figure 6 is Kangardluarsuk Fiord, looking westerly. Figure 7 shows the tide-water lake opening into Kangardluarsuk Fiord. In Figure 8 Gould is standing on the miniature hillocks of a small glacier whose ice is well covered with mud.

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[7] See "The Voyages and Works of John Davis, the Navigator," *Hakluyt Soc. Publs.*, Ser. 1, Vol. 59, London, 1880, p. xxxvi.

[8] An interesting description of the hazards attending entrance to Hudson Strait, more pronounced in the days before auxiliary power, is contained in "The Private Journal of Captain G. F. Lyon of H. M. S. Hecla During the Recent Voyage of Discovery Under Captain Parry" London, 1824. He states (p. 13): "It will, however, give some idea of the difficulties we had experienced,

On July 22 we reached Amadjuak, the Hudson's Bay Company trading post on the north shore of Hudson Strait. There we picked up the Eskimo Avalisha, who promptly accepted the suggestion that we arrange with the Post to ration his family while he accompanied us. Seemingly most Eskimos are bred-in-the-bone travelers, and possibly this characteristic is especially strong in these Foxe Land people, who are essentially nomads. In a matter of ten minutes Avalisha had bade his wife goodby, rolled his "blanket" of caribou hide, hung about his neck the little skin bag containing his telescope and minor treasures, and was ready.

On the 25th we were at Cape Dorset, at the southwestern tip of Baffin Island, cordially received by the Company's manager and his wife. The place is typical of the smaller Hudson's Bay Company posts—the store, in whose attic the skins are stored, a blubber house, a warehouse, the manager's residence, and the inevitable little powder house perched up on a ridge to the rear (Fig. 30). At Dorset we established three members of the party to pursue their special occupations and took on board the Eskimo Kavaoo.

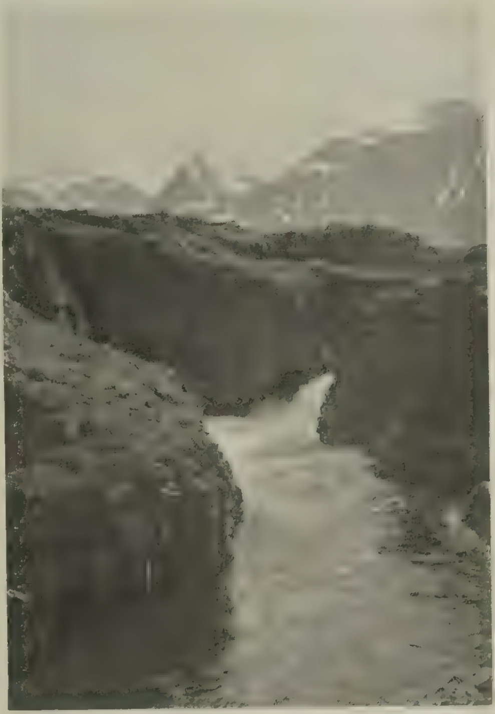
FIG. 9—The connecting canyon between the two lakes draining into Kangardluarsuk Fiord (compare the map, Fig. 26).

MILL ISLAND CIRCUMNAVIGATED

Deflected by fog and ice in our effort to work north along the Foxe Land shore, we found anchorage from July 27 to August 1 at Mill Island, a desolate mass of rock perhaps twenty miles in its longest dimension, some twenty miles south of the mainland and apparently about bisected by the 64th parallel of latitude. The exact position of the island could not be determined, for during our five

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when I observe that we were 19 days in passing Resolution Island, a distance of about 60 miles."

The Canadian Government now has an expedition in the field investigating the navigability of the Strait in connection with the construction of the Hudson Bay Railway.

days there the sun not once was visible for observations. Definite record of any previous visit by white men appears to be lacking.

On the northern shore of the island toward the westerly end, we found excellent anchorage in a sizeable harbor to which the name "Morrissey Harbor" was tentatively applied (Fig. 28). The chief entrance carries deep water, but with strong tidal currents and whirlpools just outside. Our anchorage was in seven fathoms, mud bottom. Near by was no bottom at thirty fathoms. A circumnavigation of Mill Island was accomplished in the whaleboat. Its southeastern portion is comparatively bold, but to the west and northwest appear many dangerous shoals. The main axis of the island lies northwest to southeast, similar to that of adjacent Salisbury and Nottingham islands, and not north and south as shown on the charts. Further, a strait extends across the southeasterly portion of the island, making a secondary island perhaps a third of the area of Mill Island proper. This passage, probably running about northeast and southwest, steep-walled and apparently averaging nearly a mile in width, is almost exactly straight for six miles or more.

No present-day charts indicate this passageway, though reference was made to it in 1631. In Luke Foxe's journal is the entry for September 16:

> This morning I plyde it up to the West end of the Island [Mill], and, when the Tyde was done, I put into a through-let I named *Hurin's Through-let*, for that hee, upon the foreyard, conducted in the Ship.[9]

In an editor's note anent this paragraph Mr. Miller Christy, sometime council member of the Hakluyt Society, comments: "No doubt the narrow passage between Mill Island and the small island lying close to its western side." We venture to believe "Hurin's Through-let," named for the mate of Foxe's ship the *Charles*, was not any passage between the islets to the west and the larger island but actually this intersecting waterway. It would be graceful to restore the name of Hurin, doughty British sailorman, to the charts of today and appropriate to bestow a name upon Mill Island's lesser half.

Foxe also records the fact that Bylot, in 1615, gave Mill Island its name "because of the ice grinding against him like the grinding of a mill." The fabulously swift tidal currents, with their propensity for grinding the ice and swirling it fearsomely hither and yon, are as startling today as then.

Near our anchorage ruins of ancient Eskimo winter residences were found. There were two stone houses in a fair state of preservation, the walls still standing to an average height of some two and a half feet. These were rectangular with curved corners and meas-

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[9] The Voyages of Captain Luke Foxe, of Hull, and Captain Thomas James, of Bristol, in search of a North-West Passage, in 1631–32, 2 Vols., *Hakluyt Soc. Publs.*, Ser. 1, Vols. 88–89, London, 1894, p. 381 (in Vol. 2).

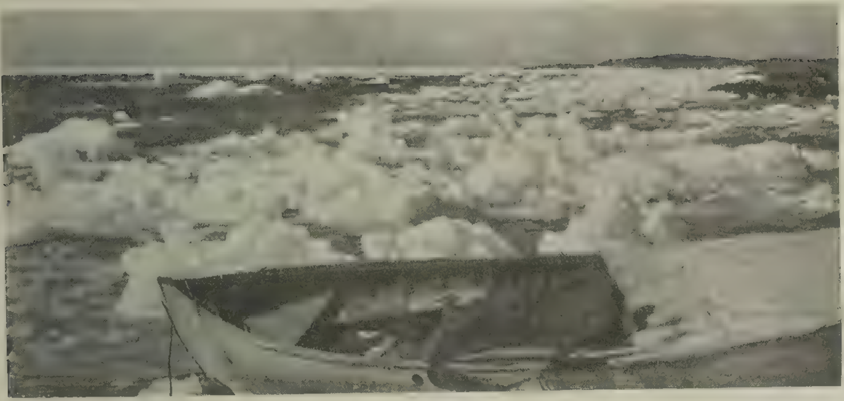

FIG. 10

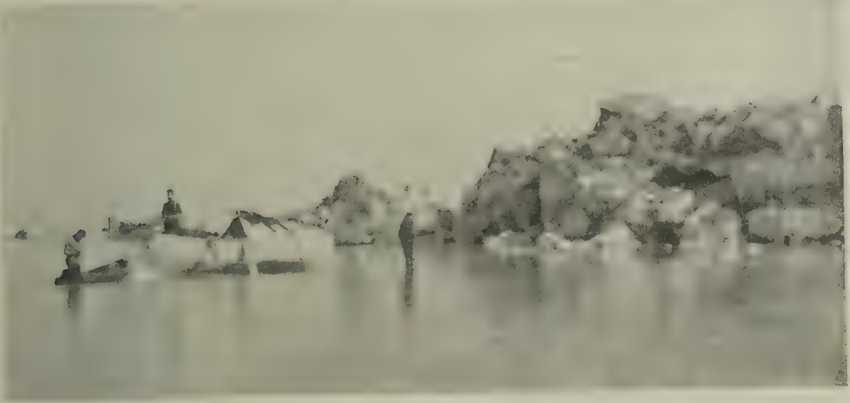

FIG. 11

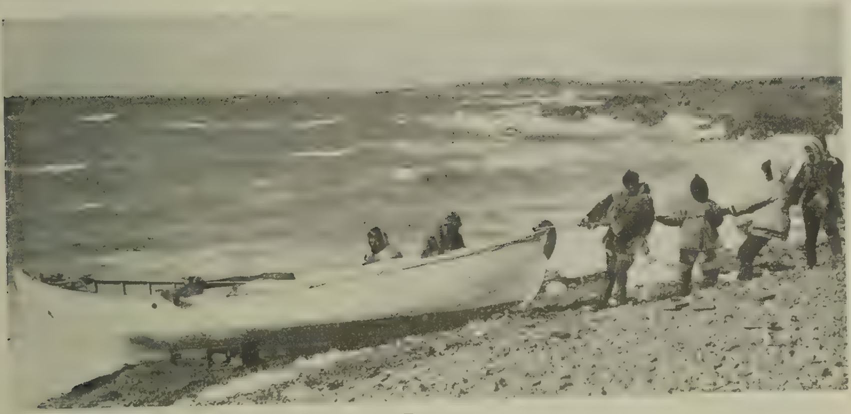

FIG. 12

FIG. 10—When the storm-driven ice attacked the beached whaleboat at Cape Dorchester.

FIG. 11—As the tide receded the whaleboat was left stranded on the mud flats, with great piles of grounded bergs about. On the eastern shores of Foxe Basin.

FIG. 12—Beaching the whaleboat in a "blow of wind" at Cape Dorchester.

ured about sixteen feet by eighteen. Junius Bird excavated the ruins, gathering an interesting collection[10] of ancient artifacts of stone, bone, and ivory, including amulets, among which were a miniature polar bear cleverly carved in ivory and a diminutive conventionalized bird, with characteristic etched decorations.[11]

The West and North Coasts of Foxe Land

After six days of continuous bad weather at Mill Island the heavy ice visible to the north appeared to move apart somewhat, and we started up the west coast of Foxe Land. That was noon, August 1. On the afternoon of the 4th we reached Cape Dorchester. The actual straightaway distance traversed is not over one hundred miles, as we later determined. Much of the run was made in fog, some of it in and around ice, and all of it without an adequate sight of the sun. So, again, observations for position were impossible. Tides and currents were strong, and beyond the Trinity Islands the occasional glimpses of the mainland, through fog or over ice, gave no clue of exact locality. Obviously such navigation along an unknown coast has its difficulties.

The word "unknown" is applied to the western boundary of Foxe Land perhaps not with literal exactitude. However, in all the long list of explorations through and about Hudson Strait, commencing with Frobisher in 1576,[12] only three expeditions directly concerned western Foxe Land and the region of Foxe Basin proper.[13] On June 22, 1631, Luke Foxe entered the Strait, that September working north past Mill Island and along the west coast of Foxe Land, believing he reached a "farthest" in latitude 66° 47′.[14]

In the summer of 1821 Parry's vessels, the *Fury* and *Hecla*, sighted the Trinity Islands off the southwestern extremity of Baffin Island on their way to the western shores of Foxe Channel and Basin. Parry also records from a position a little northeast of latitude 65° and longitude 80°, "an appearance of land . . . from N. 82° E. to S. 53° E., being part of the coast discovered by Baffin, in the year 1615, and more minutely traced by Fox, in 1631."[15]

The record of other visitations is short. Probably whalers have periodically sailed along the coast and occasionally penetrated more or less into Foxe Basin. Regarding one of these, Captain John Spicer, more will be said later. The only other vessel recorded as having sailed along the west Foxe Land coast is the *Bowdoin*, commanded by Donald B. MacMillan, which wintered at Bowdoin Harbor, near the Trinity Islands, in 1921–1922.

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[10] Presented to the Museum of the American Indian, Heye Foundation.

[11] These specimens are now being studied: it is hoped later to publish an account of the findings in the *Geographical Review*.

[12] A good summary account of some of the earlier voyages through Hudson Strait is given in "Report of the Expedition to Hudson Bay and Cumberland Gulf in the Steamship 'Diana' Under the Command of William Wakeham, Marine and Fisheries, Canada, in the Year 1897," Ottawa, 1898.

[13] It was Parry who named "the great opening leading to Fox's Farthest . . . Fox's Channel." Boas makes the distinction between Foxe Basin proper (pointing out its essentially basin-like character) and Foxe Channel (Franz Boas: Baffin-Land: Geographische Ergebnisse einer in den Jahren 1883 und 1884 ausgeführten Forschungsreise, *Petermanns Mitt. Ergänzungsheft No. 80*, 1885).

[14] The Voyages of Captain Luke Foxe, p. 394.

[15] W. E. Parry: Journal of a Second Voyage for the Discovery of a North-west Passage . . . London, 1824, p. 30.

As to the western part of Baffin Island between roughly the latitudes of 65° and 70°, only two penetrations by white men are recorded. Bernhard Hantzsch in 1910–1911 made the east-to-west traverse from Cumberland Sound through Nettilling Lake, along the Koukjuak River to Foxe Basin, and thence north along the shore apparently nearly to latitude 69°. He died in June, 1911, on the coast in about latitude 67° 30′.[16] J. Dewey Soper, of the National Museum, Ottawa, made a traverse from Cumberland Sound to the Koukjuak via Lake Nettilling in 1925, and again in 1926 to the shores of Foxe Basin.[17]

On August 5 a party set out from Cape Dorchester in our motor whaleboat, to proceed northerly along the western coast of Baffin Island, so far as circumstances permitted, and to execute a route survey. The boat carried sufficient gasoline to fuel the Palmer engine for about six hundred miles together with rations for the party of seven for thirty days. A cache of food, with seventy gallons of gasoline, kerosene, and a supply of pemmican for possible emergency, was left at Cape Dorchester. This was more than sufficient to effect a return to Cape Dorset, if need be. The whaleboat's personnel comprised the Director, Gould, Weymouth, Barnard, Pope, David Putnam, and the Eskimo, Avalisha of Amadjuak. The craft itself is twenty-four feet long, entirely open, so that the conditions were not notably luxurious, especially in bad weather—and the weather was almost continuously bad.

As already stated, the weather had permitted no observation before our arrival at Cape Dorchester, the northwestern extremity of Foxe Land. We accepted its position as shown on the chart on faith because just then there was no chance for verification. Our course, after rounding the long finger of rocks and shoals which Dorchester thrusts out into Foxe Channel, lay true east and often slightly south of east. By the chart that was altogether wrong. We thought our compass probably eccentric—the performance of the needle in this region so near the magnetic pole is anything but trustworthy. And with the continued clouds it was impossible to check up thoroughly with our Bumstead sun compass, an instrument unaffected by magnetic whims and particularly useful to us.

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[16] M. Rosenmüller: Bernhard Hantzsch und seine letzte Forschungsreise in Baffinland, *Mitt. Vereins für Erdkunde zu Dresden*, Vol. 2, 1913, pp. 669–716.

[17] See the note "Recent Canadian Exploratory Work in Baffin Island" in this number of the *Geographical Review*.

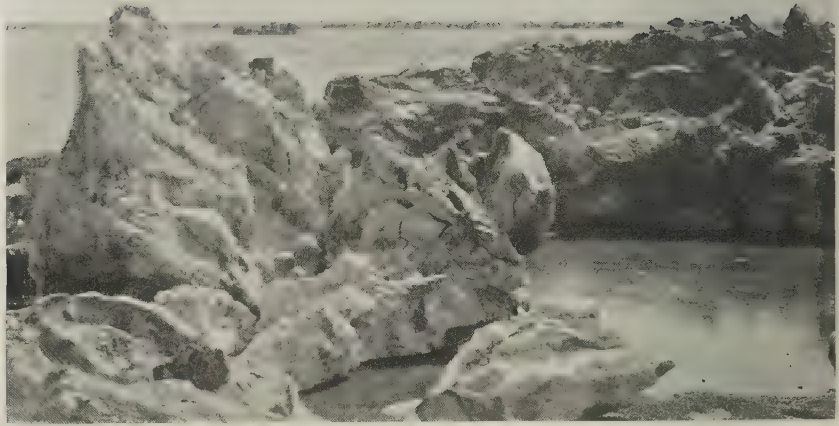

FIG. 13

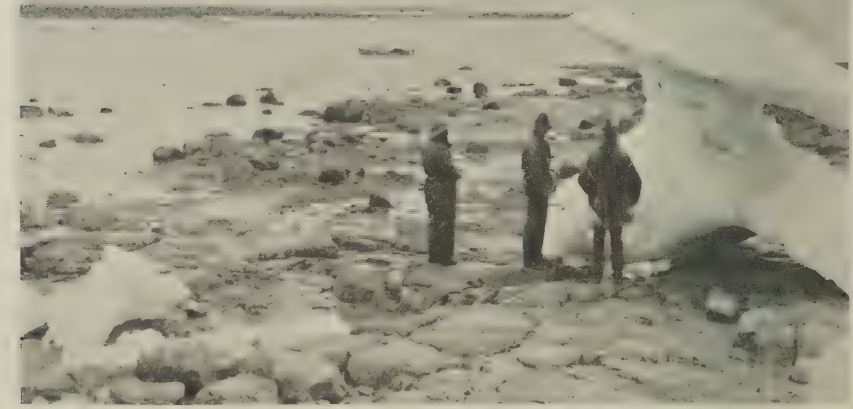

FIG. 14

FIG. 13—A typical example of the heavy, dirty, old ice of Foxe Basin, stranded at ebb tide along the shore. In distance note the clusters of stranded bergs left by the receding water.

FIG. 14—A stranded "growler," or small berg, at low tide along the Foxe Land coast. "The mushroom motif predominated." Whaleboat anchored in distance.

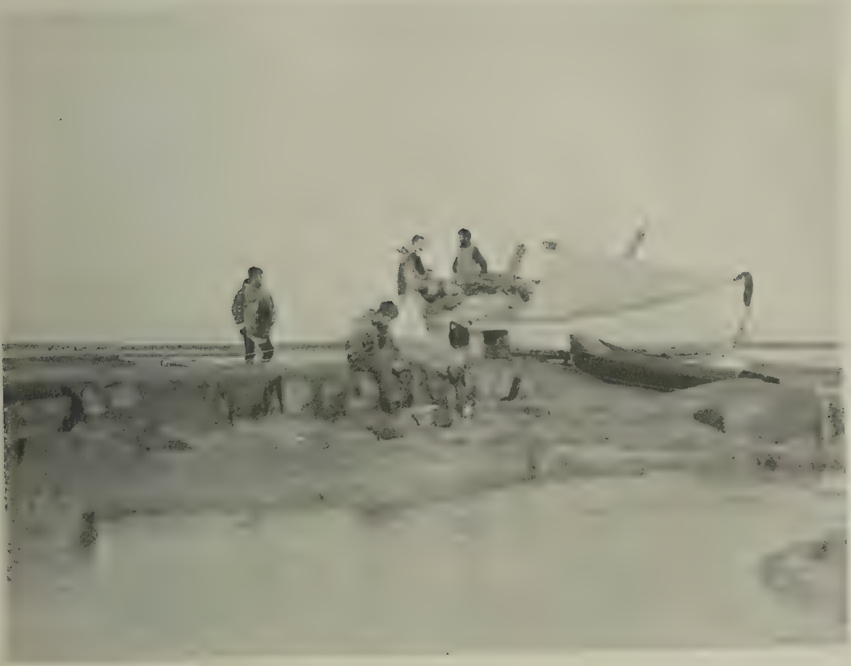

FIG. 15

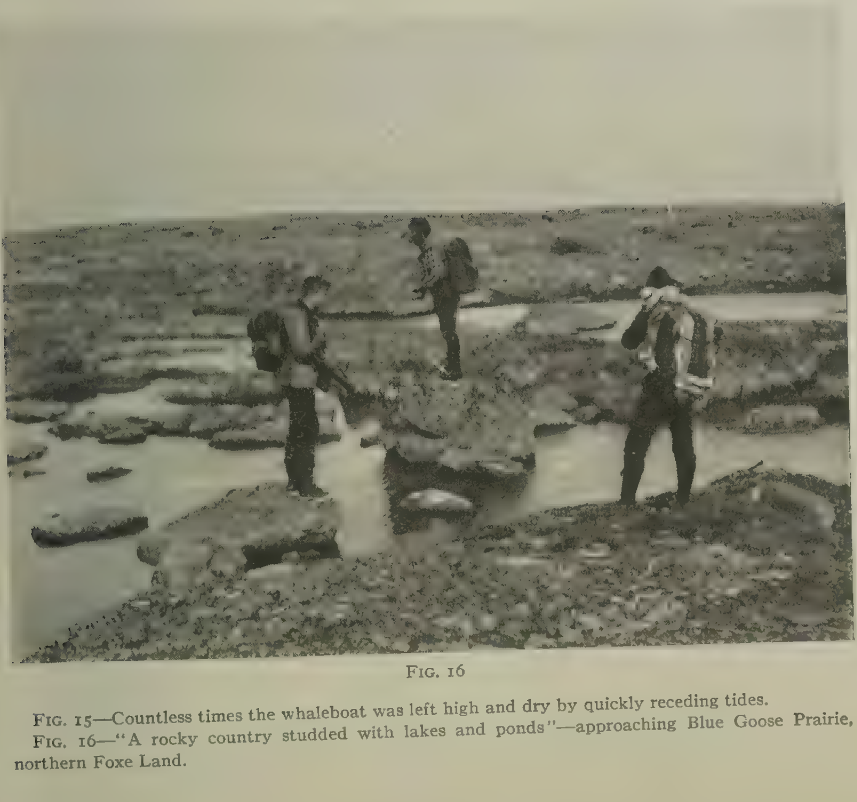

FIG. 16

FIG. 15—Countless times the whaleboat was left high and dry by quickly receding tides.

FIG. 16—"A rocky country studded with lakes and ponds"—approaching Blue Goose Prairie, northern Foxe Land.

On the second and third days Gould was able to make some observations, not overly satisfactory. These showed us even more out of harmony with the map than the compasses hinted. Finally a thorough-going observation was obtained (see the map, Pl. I). Its results were fortified by a check-up of our chronometer; Monroe Barnard, using the portable radio receiving set provided by the Society, caught the noon time signals from Washington, removing chance of error in that regard. And subsequently these first findings were corroborated with astral as well as further solar observations by Gould, to whom credit for the technical work is entirely due.

Dorchester is a cape of granite and gneiss, with rocky hills fifty feet high. At its southern side the bay reaches inland some seven miles, that estimate including the tidal flats at its extremity. Countless fresh-water ponds and pools are scattered throughout the rocky promontory. Patches of grass are few and far between, and vegetation is almost totally lacking, even moss and the customary heather-like dwarfed shrubs being rare.

Eastward the coast is universally lower. It is, indeed, simply a ribbon of granite rising just above the high-tide contour, at low water hemmed by from a half mile to a mile of rocky tidal flat, and with a sprinkling of granite islets and reefs outside. There are no hills. On a coast perhaps seventy-five miles in length there seemed to be no elevations of even fifty feet within a dozen miles of the coast. It was a desolate shore. In twenty days we saw less than that number of seal and no bear. Ducks were infrequent. Signs of fox, hare, or caribou were lacking on the coastal strip, though doubtless there were many of the latter inland. We encountered a few ptarmigan and numerous snipe.

Ice lay thick along this coast on our outward journey. The pack, of old and dirty ice characteristic of Foxe Basin, jammed in against the points and shoals at flood tide, receding and changing position laterally on the ebb and at the whim of prevailing winds. The shore itself was festooned with an endless parade of grounded "growlers" and sizable pans, the bergs, high and dry on shelves of glacier-polished rocks, rearing aloft thirty feet and more at low water or again at flood tide showing but a fraction of their upper bulk. Every point was lined with them, as was also each protruding reef beyond the points. Picturesque they were, some of them huge, many of them fashioned by the tide-driven waters into grotesque shapes, a sort of gigantic mushroom *motif* predominating.

From what we saw of the movements of the great ice fields outside and could judge of the prevalence of shoals, it seemed it would be practically impossible for a vessel of any draft to navigate along these shores. Even for our whaleboat it was difficult and dangerous enough. Where the old pack ice came in close our only chance of progress lay in "cutting corners"—that is dodging along close inshore as tide and ice movement permitted, often in less than a fathom of water and pretty much at the mercy of six-knot currents. Where a shoal was studded with grounded bergs and the pack prevented passage around it, we perforce cut through, sometimes in veritable rapids where the tide raced madly over the shoals, often with only a few inches of water between us and bottom.

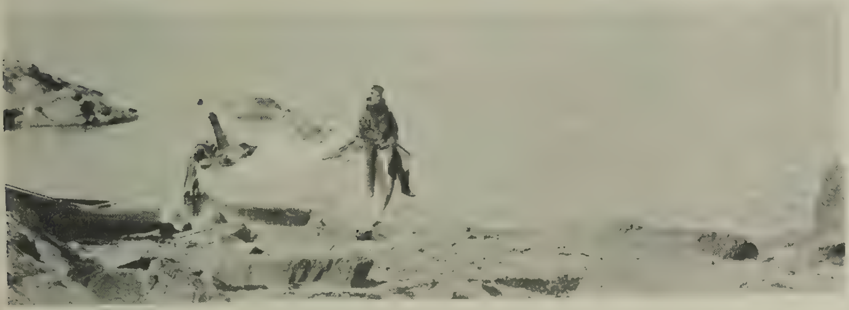

FIG. 17

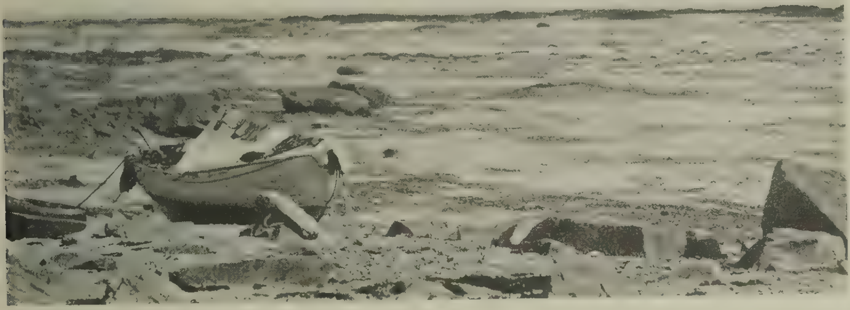

FIG. 18

FIGS. 17 and 18—Photographs taken from the same spot near Camp Walcott on the northern coast of Foxe Land. Figure 17 shows high tide; Figure 18, low tide. The range of the tide is about 28 feet.

A large and deeply indented bay constituting the southeastern extremity of Foxe Basin marked the termination of our run easterly from Dorchester. West of its head in latitude 65° 32′ N., longitude 74° 30′ W., lay our base of operations which we named Camp Walcott. The land adjacent to the westerly portion of this bay and south from its head held a far larger measure of interest than the previously encountered territory. The shore itself, still granite and gneiss, is generally considerably higher, some of the headlands being distinctly abrupt. There are numerous ledges, and the upper reaches of the bay are extremely shallow, low water exposing mud-and-rock tide flats probably five miles in width.

The small hills near the shore had maximum heights of perhaps one hundred feet. Farther inland to the south and west, the country opened up into marshy plains interspersed with "islands" of rock, both the meadowlands and rocky surfaces cut up with innumerable small lakes. Grass and moss abounded, and there were evidences of great numbers of caribou. The prevailing bad weather, it is believed, had driven the herds to better protection in a more hilly region visible farther inland. Two days of hunting bagged six caribou for our larder, periodically supplemented with duck, snipe, and ptarmigan. The latter and eider ducks were fairly numerous; a number of Arctic white owls were seen, some hare and weasels, and ample evidence of lemmings, but signs of fox were rare. The shallow ponds and prairies of the hinterland swarmed with geese. In the bay itself a single bearded seal and a white whale alone were observed.

To the southeast of our camp on the bay, about fifty miles distant, lay the one distinct landmark of the region. To this highland we back-packed, finding it a group of veritable mesas of limestone, with an average altitude of some seven hundred feet, rising from a flat, semi-inundated prairie but slightly above high-tide level. The strata proved highly fossiliferous. Even in our brief examination hundreds of fine specimens were seen.

For the vast marsh at the base of the Highlands, extending perhaps over an area twenty miles square, we are suggesting the name "Blue Goose Prairie." There the junior member of the party, David Binney Putnam, contrived to kill four of these extraordinarily shy geese. Through the subsequent identification[18] of one of the bird skins it developed that we had stumbled upon a populous summering place of the much-sought blue goose, whose nesting *locale* hitherto has remained an unsolved ornithological mystery. We saw no nesting places and no eggs, the season evidently being far too advanced. Most of the young seen were matured enough to fly. Presumably the migration southward this year commenced September 10. On that date we were in Chorkbak Inlet, about seventy-five miles almost directly south of this particular region; for two days and nights, quite continuously, magnificent "V's" of geese honked southward within our field of sight or hearing. None before that date had been observed.

The head of this great bay marks the end of the eastern sweep of the shore line; there it turns and extends west of north. And

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[18] Examining this in New York, Dr. Frank N. Chapman of the American Museum of Natural History says: "Your bird is a blue goose (*Chen caerulescens*) passing from the downy plumage in which it was born to the juvenal or first flight plumage. It was obviously, therefore, taken on or in the vicinity of its nesting place and consequently marks the discovery of a spot in which this species breeds."

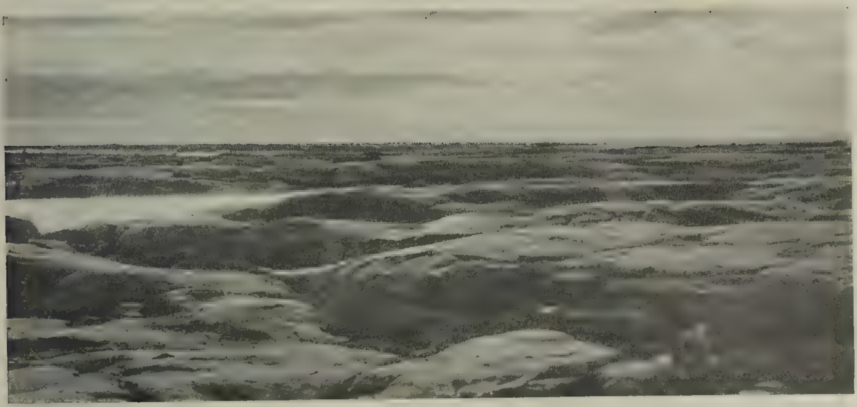

FIG. 19

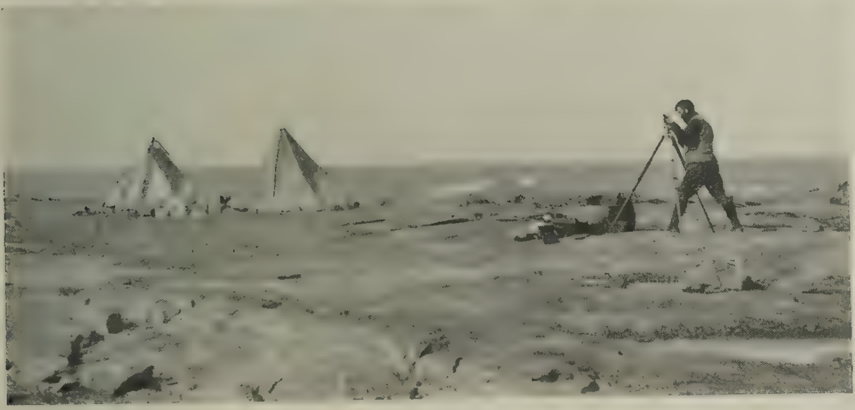

FIG. 20

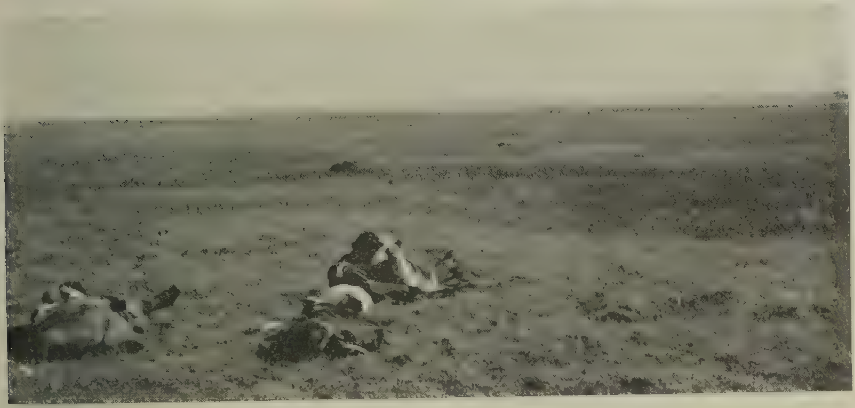

FIG. 21

FIG. 19—Typical terrain of the northern Foxe Land coast explored by the whaleboat party.

FIG. 20—Camp on the glacial polished granite of the Foxe Land shore line.

FIG. 21—Resting on the great prairie where the rare blue geese were shot, across which the party back-packed inland.

beyond it the coast and visible hinterland assume a different character; the granite foreshore, with its rock-bound tidal flats, is succeeded by a terrain of mud, gravel, and swampy plain of limestone base, with mud tidal flats, amazingly level, reaching out to sea for miles.

From the bay we followed up that peculiarly horizontal coast zone for some hundred miles seeing no variety whatever. For probably twenty miles inland there appear to be no altitudes of more than a dozen feet above high-tide contour. The mud flats reach out from the ribbon shore line often at least five miles, probably ten or more. The tides range from twenty to thirty feet with terrific currents. Fields of heavy ice and acres of "growlers" and loose pack seem forever plowing along the coast. Three miles off, the lead might show a fathom and a half of water. The technique of making a landing is to let the tide leave you dry on the mud, say half a mile out. Thence you sludge in to the semblance of beach, taking care not to be caught by the swift rising water of the next tide.

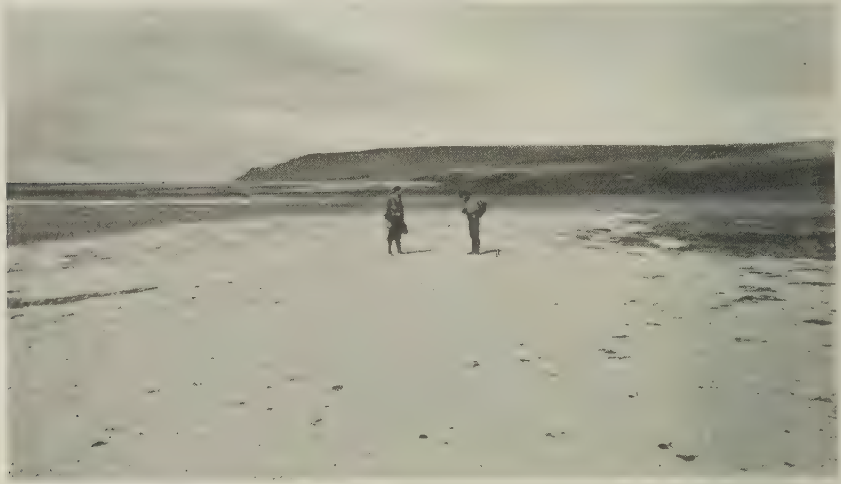

Fig. 22—Along the base of the highland inland from the southeastern corner of Foxe Basin, Blue Goose Prairie at the left (see Fig. 33).

Altogether, it is a place of manifold navigation hazards and peculiar problems. One becomes increasingly convinced that a small power boat is the only possible craft with which to negotiate it. Light draft is essential, and a boat sufficiently handy to be beached and even hauled up, if need be, is advantageous. That point especially was brought home to us when we returned to Cape Dorchester. A gale of wind, driving full into the harbor and upon our beach, first brought a rough sea and breakers and then heavy ice. The whaleboat, anchored, would scarcely have survived the first, while the pack would have made kindling wood of it in ten minutes. So we got her well up on the beach, in very satisfying safety. For such occasions, in amphibian navigation such as this, blocks and tackles make an admirable item of equipment, plus a boat of maximum sturdiness and minimum bulk.

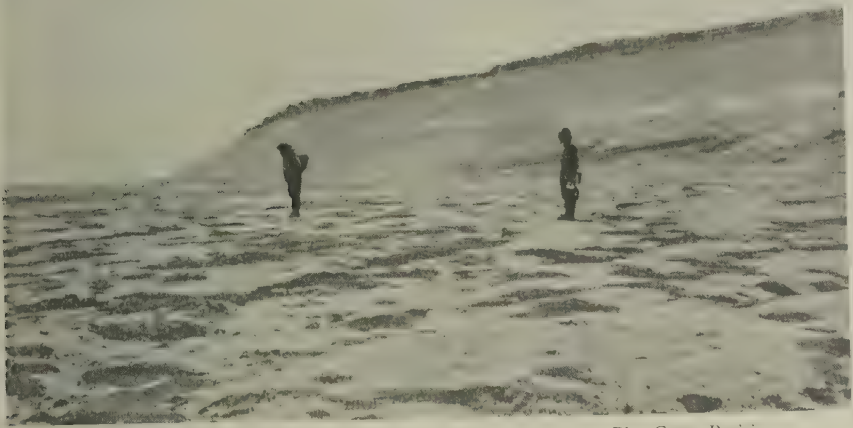

FIG. 23—A nearer view of the scarp of the highland rising from Blue Goose Prairie.

In his "Journal of a Second Voyage," Parry says of the ice at the entrance to Foxe Channel: "We saw no more on our return to the eastward, which circumstance agrees with the accounts of Baffin in 1615, and of Fox in 1631 . . . I have no doubt that the same clear sea would be found to extend some distance to the northward of where Fox turned back" (pp. 482–483). The whaling captain, Thomas McKenzie, has expressed the opinion that "on the east shore of Fox Channel there is generally open water in summer."[19] This season we encountered much ice in the eastern part of Foxe Basin in early August and at the northern end of Foxe Channel at the close of the month; and in eastern portions of the Basin heavy pack ice was found in great quantities by both the whaleboat party in the southeast and by the *Morrissey* farther north. From which it would appear that any freedom from ice in either Channel or Basin cannot be counted upon.

We returned to Cape Dorchester on August 25, having covered in the whaleboat approximately five hundred miles. And there Gould's further observations, both solar and stellar, removed any vestige of doubt as to the Cape's true position. Also there magnetic observations were made for the Carnegie Institution by George Weymouth, under Gould's direction, completing a series of three.

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[19] Report of the Expedition to Hudson Bay . . . in the Steamship "Diana," p. 54.

Oceanographical Observations by Captain Bartlett

Throughout the greater part of the month of our absence in the whaleboat Captain Bartlett had the *Morrissey* in Foxe Basin (see Fig. 25). He prosecuted the first oceanographical work undertaken in the Basin. An extensive collection of plankton, gathered with surface nets at points representative of the area, was made for the Buffalo Society of Natural Sciences. In addition he dredged many specimens from the bottom, to be submitted to the Smithsonian Institution; took soundings and water temperatures; observed tides and currents; and released drift bottles for the U. S. Bureau of Fisheries. Captain Bartlett's summarization follows:

"In Foxe Basin our 'farthest' was off the entrance to Fury and Hecla Strait. Weather and ice conditions were about as unfavorable as could be, throughout. Constant fogs hindered nagivation, and near the Strait we were checked by heavy northwest gales. The Strait appeared quite free of ice and with favorable weather, and a little more time, I believe we could have gotten through comfortably although progress to the north would be problematical. Contrary to a commonly expressed opinion I believe in many seasons a small power vessel could negotiate the Strait comparatively easily.

"Near Cape Dorchester we saw some sizeable bergs, measuring perhaps 70 feet in height. Could they have come all the way from the mouth of Hudson Strait, an inland drift, up around Cape Dorset, of about five hundred miles? While there certainly is a prevailing westerly current along the north shore of Hudson Strait, I believe the prevailing current in Foxe Channel moves south. Could they have come from the north, by way of Fury and Hecla Strait? That is an even longer drift, in through Lancaster Sound and the Bay of Boothia. Is there possibly a glacier, comparatively near, bordering the waters north of Fury and Hecla?[20]

"We reached within about two miles of the village of Igloolik before we had to give up because of the northwester. However, from a neighboring shore we picked up two Eskimos who said the village was deserted just then, every one, as we understood it, being away hunting caribou.

"The ice of Foxe Basin is heavy and generally much like that found in Kane Basin. But it seems older and is amazingly dirty, covered with mud, pebbles, and kelp. Evidently what we saw was not made last winter—there was plenty of clean newer ice. I believe much ice must remain in the Basin from one year to another, and not move out seasonally as from Kane Basin and Smith Sound. There

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[20] Robert Bell in "Report of an Exploration on the Northern Side of Hudson Strait" (*Canada Geol. Survey Ann. Rept.*, Vol. 11 (N. S.), 1898, Ottawa, 1901, p. 13M.) says: "During my visit to these regions in 1884 and 1885 vague reports reached me of the existence of glaciers on some parts of the shores of Fox Basin, but as no icebergs have been seen in the basin nor any known to come out of it, should there be any land ice in that direction it does not appear to reach the sea."

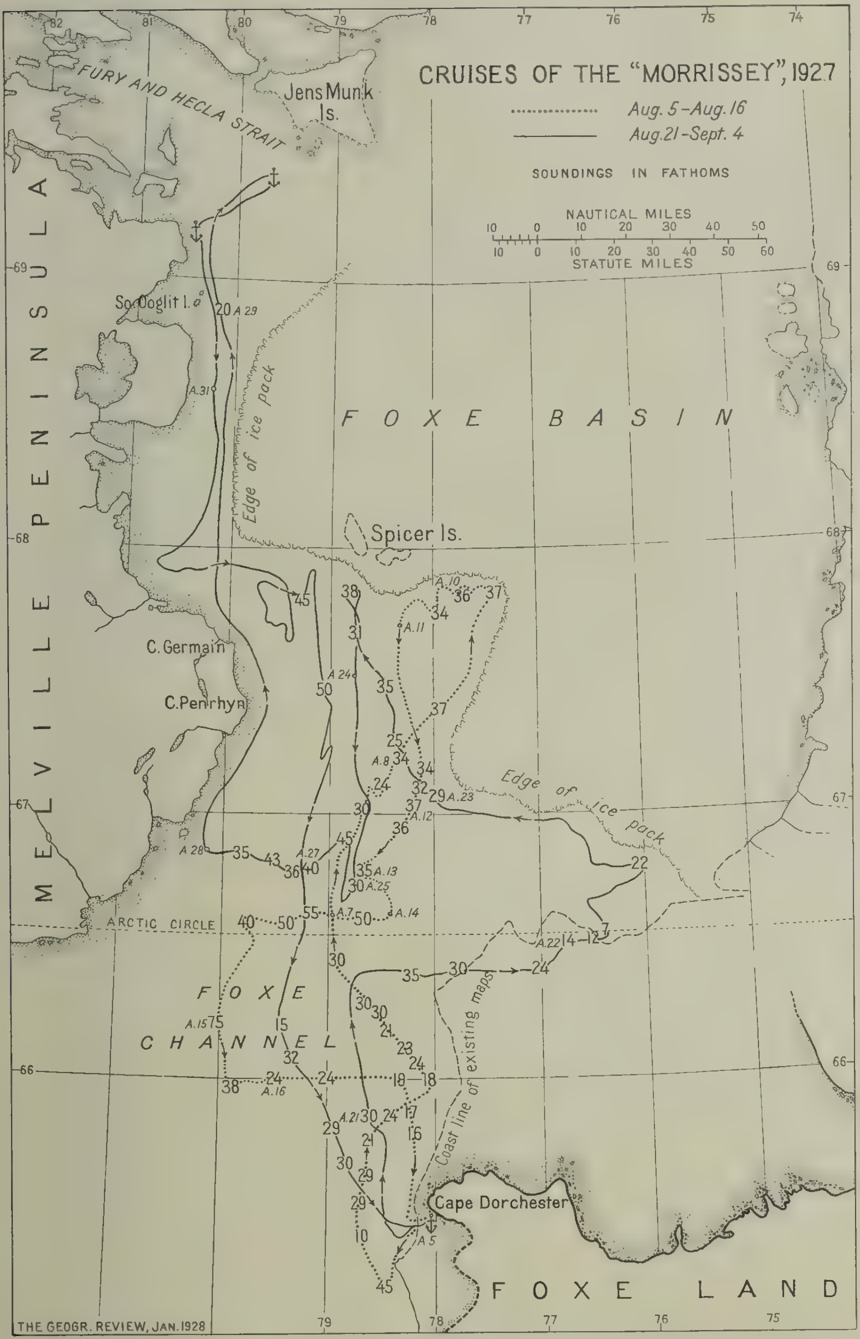

FIG. 24—Map of Foxe Channel and Foxe Basin showing depths determined by Captain Bartlett in two cruises, August-September, 1927. Many more soundings and other oceanographical data were obtained. The Spicer Islands were not sighted: presumably they are not in their charted position. Scale of map 1:3,250,000.

were enormous packs milling around the Basin apparently most extensive to the northeast. We were in them a good deal, and there and fog-bound along the west coast by Melville Peninsula, I had opportunity to observe somewhat how the currents churned around. There were no definite sustained directions of progress. The movement seemed pretty much circular. This substantiates my theory that much ice rotates around in the Basin, probably actually being cleared out only in summers of strong and protracted northerly winds.

"Twice we were within a few miles of the charted position of the Spicer Islands, blocked by ice from getting closer. I could see no land. Possibly their position is incorrectly set down. At all events, at about their given locality I found thirty-eight fathoms of water.[21]

"There was a surprising lack of animal life. We saw no bear, very few birds and waterfowl, and few seal. Walrus were encountered only near Cape Dorchester and near Fury and Hecla Strait. On the other hand the bottom flora and fauna appeared unusually rich."

Chorkbak Inlet

The *Morrissey* joined the whaleboat party at Cape Dorchester on September 4. Thence the vessel proceeded via Cape Dorset to Chorkbak Inlet, where five days were spent. Thus is Chorkbak laconically described by the "Arctic Pilot": "said to be the longest inlet on the north side of Hudson Strait, but it has not been examined." The map of the Northwest Territories for 1926 gives no indication of the inlet, but Boas on the basis of Eskimo accounts shows the fiord and its two arms, Sarbak and Sarbausirn, in dotted lines on his map of Baffin Land, and it appears similarly on the Admiralty Chart 2177.

R. J. Flaherty,[22] who wintered in southern Foxe Land 1913–1914, had reported Eskimo accounts of this little-known fiord. He was told that its tides, ice, and "maelstroms" were exceedingly dangerous and understood that in the past the inlet was used as part of a regular cross-country route from Hudson Strait to Foxe Basin. This latter was to us especially interesting, as actually the head of Chorkbak is distant from the established southeastern extremity of the Basin probably not more than fifty miles in a direct line, a fact previously unsuspected.

Of ice in Chorkbak we found none (September 10). The tides were strong, with a rise of between twenty and twenty-five feet; but after those of the Foxe Basin shores, they did not appear particularly formidable to us. The *Morrissey* proceeded up the inlet perhaps twenty miles, and examination by whaleboat was continued to the head of both branches, thirty-five to forty miles from the mouth, which itself is screened by countless islands, all uncharted—a continuous screen along the coast westerly to Cape Dorset.

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[21] The Report of the Expedition to Hudson Bay . . . in the Steamship "Diana" (pp. 57–61) includes a statement of the American whaling captain, John Spicer of Groton, Conn. It sets forth that in 1879 his ship the *Era* penetrated Foxe Basin. "On the 7th of August was beset; what I took to be water ahead turned out to be reefs and lowland, now called Spicer's Island, hardly seen from decks at high water" (p. 59). There is no record of other sighting of the islands.

[22] R. J. Flaherty: The Belcher Islands of Hudson Bay: Their Discovery and Exploration, *Geogr. Rev.*, Vol. 5, 1918, pp. 433–458. See p. 443 and the map, Fig. 1, p. 434.

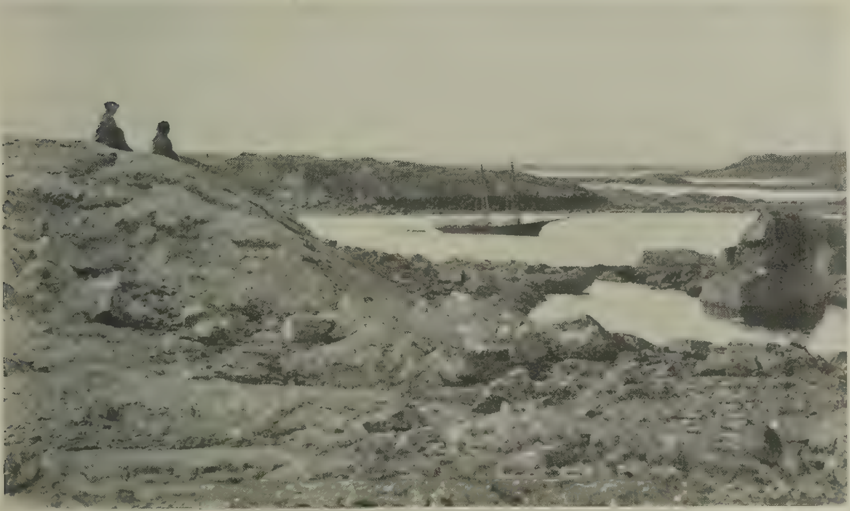

FIG. 25—The *Morrissey* anchored in a bight of Chorkbak Inlet.

Chorkbak we left on September 12 and on the 17th passed out of Hudson Strait and headed south, homeward bound. Sydney, N. S. was reached on October 1, after we had logged in all some 6000 miles.

NOTE ON THE MAP OF FOXE LAND

In the current charts the western and northern coasts of Foxe Land are primarily based upon the findings of Foxe in 1631, as later interpreted by Parry in 1824.[23] Parry placed Cape Dorchester at about latitude 66° 28′—its position actually being 65° 32′, assuming that the name "Dorchester" shall be applied to the cape that is literally the northwestern extremity of Foxe Land. To analyze the pertinent and often conflicting passages would require too much space here.[24] Suffice to say that Foxe seems to have hit upon the latitudes of Cape Queen and Cape Weston (as placed on the present chart) pretty accurately. His placement of Dorchester and Willoughby and his estimate of his own "farthest" are more hazy and, as to the former, incorrect—an error which almost inevitably affects the latter. Curiously, he sets down that from Cape Weston "the land doth trent to the s—ward of E—" which is what the land actually does at Cape Dorchester.

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[23] Parry, *op. cit.* See the map (4th at the end of his volume) entitled "Chart of a part of the North Eastern Coast of America, and its adjacent Islands shewing the Track and Discoveries of His Majesty's Ships Fury and Hecla, in search of a North West Passage, under the Command of Capt^{n}. W. E. Parry in the years 1821. 1822. 1823."

[24] See The Voyages of Captain Luke Foxe, pp. 384–394. See also the earlier account of Foxe's journey, "Voyage of Captain Luke Fox," forming Narrative No. 12, pp. 152–186, in: "Narratives of Voyages towards the North-West, in search of a Passage to Cathay and India. 1496 to 1631. With selections from the early records of the Honourable the East India Company and from Mss. in the British Museum," by Thomas Rundall, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 5, London, 1849.

September 20, 1631, he made his "farthest," as he computed, "some mi. within the *Artick Cirkle*"—that is 66° 30′. The weather for Foxe apparently was as difficult as we ourselves found it, with a possibility that actual observations, if any, were undependable. Possibly the positions were built up chiefly on estimates. At all events, Foxe's log showed snow on the 19th; the entry for the 20th records "cloase weather, some snowie," and on the 21st, "this day wee see the Sun, but to no use."

In the construction of the map of Foxe Land by the Putnam Baffin Island Expedition the following positions were astronomically determined. A portable radio receiving set supplied by the School of Surveying of the American Geographical Society made possible the frequent checking of the chronometer:

Latitude	65°	25.9′ North*	Latitude	65°	31.5′ North*
Longitude	77°	45.6′ West	Longitude	74°	30.3′ West
Latitude	65°	25.4′ North	Latitude	65°	46.7′ North*
Longitude	75°	18.6′ West	Longitude	73°	51.1′ West.

The above positions were determined by observations made with theodolite; and for those starred, time signals were obtained on the date of the collection of the data.

Meridian altitudes of the sun, measured with the sextant for latitude, and approximate longitude from these data characterize this farthest north position:

Latitude	66°	17′
Longitude	74°	40′.

For further construction of the map from these positions as pegs to hang the data on, as it were, the simplest reconnaissance methods were necessarily employed. Except for a limited area about Camp Walcott and the southeastern bay of Foxe Basin, mapping was done from the whaleboat. This twenty-four foot boat drew scarcely two feet of water so that it was possible to keep fairly close to the coast in most cases. Distances were determined by the use of a taffrail log or, in places where shoals were too numerous to use the log, by time allowance—the rate of the boat having been previously checked for various engine speeds. A pelorus was used for locating more prominent points and features. Directions were determined so far as possible by the Bumstead sun compass. Periods of bright sun were so transient that it was rarely possible to use this compass for steering the boat, but it did make possible the frequent checking of the two magnetic compasses which were constantly used.

On account of the inland trek from Camp Walcott to the highland, it was possible to locate points hereabouts by rough triangulation, supplementing data gathered from the boat.

Observations for terrestrial magnetism were made by a representative of the Carnegie Institution in 1922 at a point on the west coast and at two places on the north coast of Foxe Land, the latter being:

Latitude	65°	24.4′ North
Longitude	76°	41′ West
Latitude	65°	19.9′ North
Longitude	75°	54′ West.

These data furnished welcome reënforcement for positions estimated by us by dead reckoning on a part of the coast where weather prevented us from making satisfactory astronomical observations.

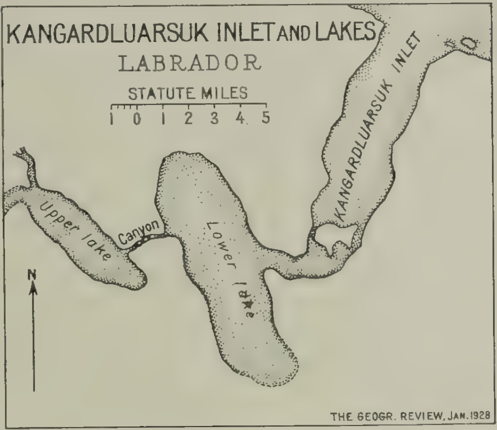

FIG. 26—Map of the lakes discovered draining into Kangardluarsuk Fiord on the Labrador Coast, 59° 36′ N. Lat. (see Figs. 2, 6, and 7).

Report on the Physical Geography

BY LAURENCE M. GOULD

KANGARDLUARSUK INLET AND LAKES

Maps of the northern part of the Labrador coast are still very imperfect, and one cannot always be sure of his exact location. The inlet in which the *Morrissey* was beached and of which a reconnaissance survey was made appears to be Kangardluarsuk of the existing mariners' charts. A single solar observation for latitude indicated such a position (59° 36′ N.).

Proceeding inland from the head of Kangardluarsuk Inlet one first encounters a lake of salt water separated from the parent inlet only at low tide. Like the inlet itself it occupies a valley scoured out by one of the tongues of ice from the eastern side of the Torngats. Striations and other glacial markings are noticeably more evident here than in the rocks adjacent to the coast; their strike is parallel to the axis of the valley.

About a mile and a half beyond is another lake lying 160 feet higher. Unlike the lower lake it is not a typical rock-basin lake whose bed has been entirely scoured from the rocks by glacial ice, for its eastern shore consists in part of an imperfect moraine. It is comparatively shallow, especially along this shore where wave action has built a flat sandy plain of considerable extent. Winds have blown the sand into small dunes, and a struggle is in progress between the encroaching sand and the dwarfed subarctic vegetation. Both the shapes of the dunes and the distribution of the vegetation indicate prevailing and persistent winds from the southwest. Beyond this sandy zone are numerous shallow ponds surrounded by muskeg.

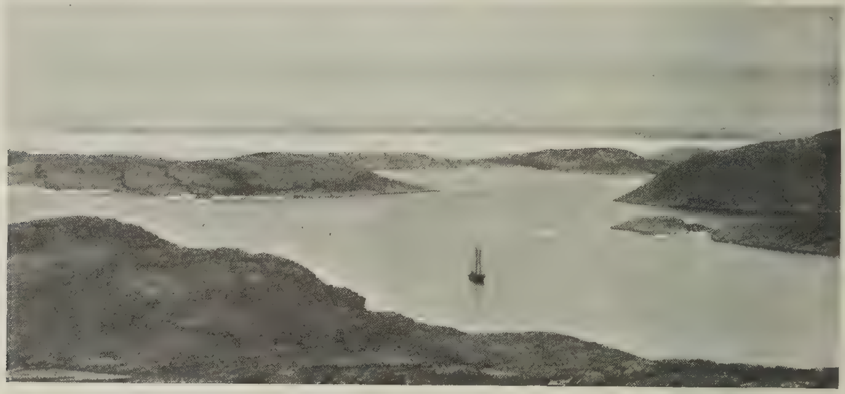

FIG. 27—The *Morrissey* in the harbor discovered on Mill Island; looking approximately northeast.

On the lee side of the divide that separates the lakes are a number of small but permanent patches of ice which exhibit many of the characteristics of true glaciers. Outwash aprons are in process of active formation at their feet, and in some cases tiny lateral moraines have been developed. Their surfaces are covered with débris and exhibit on a small scale the same sort of cones, pyramids, and ridges that characterize some of the great mountain glaciers (Fig. 8). A few crevasses expose a blue-gray ice beneath the mantle of dirt.

MILL ISLAND

After the relatively low islands of Hudson Strait, Mill Island presents a fairly rugged appearance as approached from the north. It has been completely covered by a continental ice sheet, and its great convexly rounded surfaces of pre-Cambrian crystallines rise abruptly from the sea to heights of 200 to 300 feet. Farther inland these forms attain heights in excess of 500 feet. The symmetry and perfection of these glorified *roches moutonnées* are modified by a rectangular fracture-fault system which is fairly spectacular in the perfection of its development and admirably exposed through the almost total absence of vegetation and of glacial drift except for that which has been reworked into beaches and associated forms. One set of fractures has a strike of N. 40 E., and at right angles to it is a second set equally prominent. Scarps of 50 feet are common along these lines, and there appears to have been some block faulting. One rectangular valley within the island has originated in this manner, and the large island lying to the southeast of Mill Island proper is separated from its parent mass by a graben.

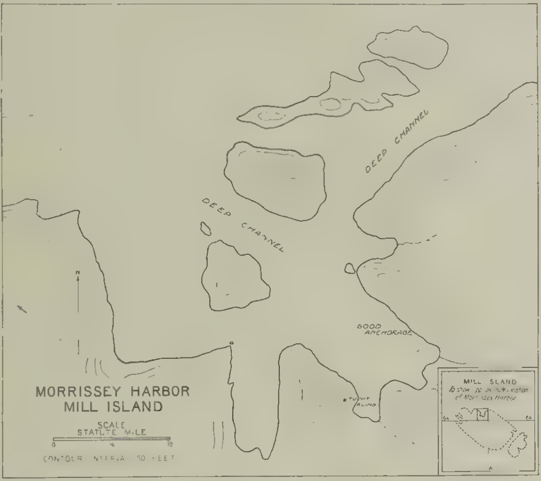

FIG. 28—Map of Morrissey Harbor, Mill Island.

The island is remarkable too for its series of terraces, far exceeding in their perfection any seen at other of the places visited on the Labrador coast and on Baffin Island. Proceeding inland from the head of Morrissey Harbor, one ascends the heights of the island by a great stairway of such terraces with treads spaced as follows: 40, 100, 170, 185, 225, 250, 280, 325, 350, and 500. These figures represent elevations above sea level measured in feet. At several other places on the island beaches were noted at an altitude of 500 feet. This figure does not, however, represent the total amount of postglacial emergence. At no place were the rocks covered by undisturbed drift, and erratics are by no means common on unprotected places; the whole island appears to have risen from a condition of almost, if not quite, complete submergence in postglacial time.

BAFFIN ISLAND

From Big Island to Cape Dorset the general character of the coastal region of Baffin Island is somewhat similar to that of southern Labrador. It is a ragged and forbidding coast with numerous inlets of varying size, fringed by barren rocky islands. Devoid of any notable landmarks, it is a bewildering place to navigate. The flattened convex profiles of the islands are duplicated in the hills and knobs on the mainland. So much alike are all these forms that an elevation of the coast line would simply decrease the number of islands without sensibly affecting its present appearance, and conversely a submergence would but deepen the inlets and increase the number of islands.

It should be pointed out that there are three mountain ranges along the eastern side of Baffin Island with the highest nearest Greenland. It is the southern ends of these mountains that give character to the relief of the coast from Resolution Island to a point somewhere in the vicinity of Amadjuak. Mountains from 1000 to 2000 feet in height are common on the mainland, and the islands that border this part of the coast are likewise high and in many places rise sheer from the water to heights of several hundred feet. At Chorkbak Inlet the highest elevations would probably not exceed half of the smaller of the above figures, and from here westward to Cape Dorset the land does not appear to become more rugged. We penetrated inland to the head of Chorkbak Inlet and found that with northward progress the relief became considerably flatter.

Suggestions of a definite system of fractures and faults are found in the shapes of some of the coastal forms, particularly the inlets, and in the orientation of some of the islands; but it is behind this zone itself that their patterns are more distinct. An imperfect checkerboard design may be made out in some places but in no case on such a grand scale as that exhibited on Mill Island. Some of the side inlets from Chorkbak proper have rectangular outlines, and vertical scarps form parts of the walls of the inlet itself. It is apparent that faulting has played an important rôle in the development of this great fiord.

The rocks are pre-Cambrian crystallines, coarse biotite and hornblende gneisses and schists being the commonest types with a coarse-grained reddish granite present as intrusive masses and assuming considerable importance locally. Near Amadjuak there occurs a band of coarse crystalline limestone or marble.[25] Robert Bell, who charted the south coast of the island from Chorkbak to Big Island and who studied the geology of these shores, states that there are at least ten great bands of this limestone along this particular stretch of the coast. We positively located none beyond Amadjuak on the south coast and none along the whole stretch of the north coast. Nearing Cape Dorset a great band of whitish rocks several miles inland to the north was seen. This may be such limestone or marble.

From Cape Dorset to Cape Dorchester no stops were made, and the course of the *Morrissey* was too far from land for us to make any specific observations; but apparently with the northward trend the land forms along the coast become flattened. At Cape Dorchester a noticeably different character is evident in the topography. The general level of the land over the whole cape and apparently far inland is much lower. Most of the cape itself is less than 50 feet above high tide, and no elevations above 100 feet were found. The prevailingly rounded forms so characteristic of the south coast have been largely, and in some places completely, modified by the ribbed structure of the rocks. Considerable amounts of reddish granite in conjunction with the structure give these rocks the appearance of sandstones, even from short distances. Any suggestion of the convex profile of glacial erosion is totally lacking in many places on the cape.

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[25] Bell, *op. cit.*

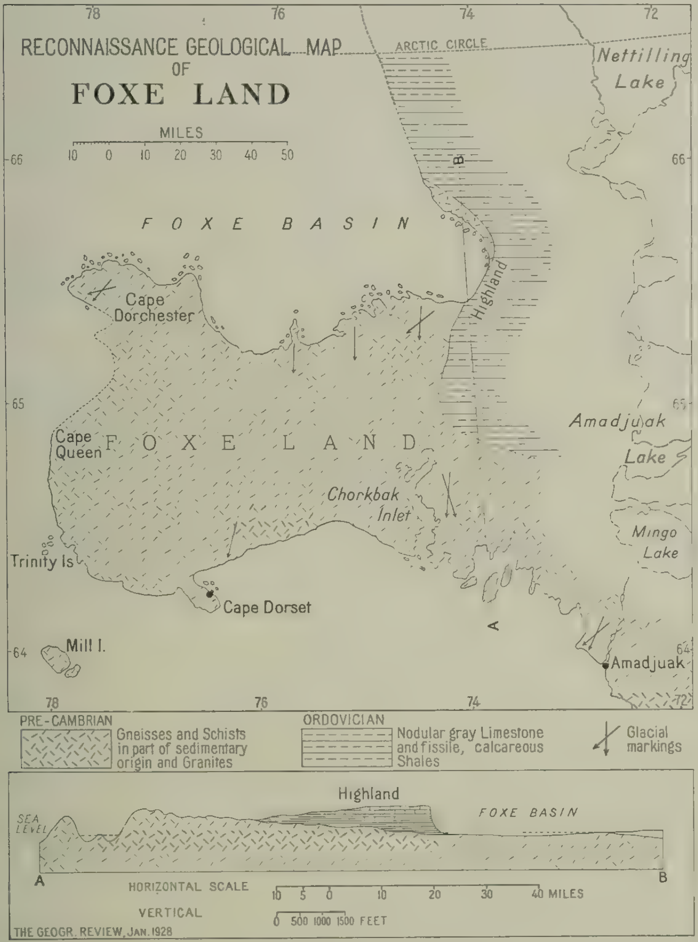

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FIG. 29—Reconnaissance geological map of Foxe Land with a diagrammatic section from north to south across the eastern border. (In the section Ordovician should be shown at B by horizontal ruling.) Scale of map 1:3,500,000.

Eastward from Cape Dorchester the general level of the land becomes even lower, and for many miles beyond longitude 76° glacial denudation has completely obliterated all evidence of structural control and has produced a surface almost completely in one plane. Low islands and shoals are particularly numerous along this part of the coast and project their elongate rounded forms above water like the backs of great whales. The effect produced is strikingly like that of the infinitude of islands along the northeastern shores of Georgian Bay in Canada.

Along the mid-sections of the north coast of Foxe Land garnet becomes such an abundant accessory mineral that the rocks can be properly referred to as garnetiferous gneisses and schists. Similar if not identical rocks were noted toward the head of Chorkbak Inlet.

In the vicinity of Camp Walcott and for perhaps twenty-five miles to the westward an intrusive porphyritic granite, with dikes and stringers of irregular shape cutting into the surrounding gneisses and schists, comprises a considerable part of the whole rock mass. The monotonous character of the landscape here is somewhat relieved by low knobs and flatly convex profiles of greater extent. But even here there are no real hills, and the general land surface does not exceed an altitude of 120 feet. About fifteen miles of the inland trek from Camp Walcott lay across this glacial plateau (Fig. 33). The greatest elevation noted was 160 feet. A much greater part of this surface is covered by shallow lakes and ponds than is indicated by the narrow strip on the map. These lakes are generally rock-bound, with basins quite free of débris except for small accumulations of organic matter. In some places drift comprises a portion of the shore line, replacing the rocky bank with soggy and slippery muskeg. In not a few places where the water level of these rock-bound lakes had fallen, a black strip between the two levels was conspicuous. This black stain proved to be a superficial crust quite like certain types of desert varnish in appearance. Mr. M. W. Senstius informs me that the phenomenon is common under similar conditions in Canada and that the black stain is manganese dioxide.

Blue Goose Prairie is part of a very recent coastal plain. It is really a great swamp of grassy bogs and shallow lakes. One sees patches a few yards or rods across that normally lie above water level whereon is exhibited in considerable perfection the results of the subarctic process of solifluction which produces hexagonal forms of bare soil, surrounded by grassy fringes. Few of these upheaved masses were more than three or four feet across.

Reference has already been made to the contrast in physiographic form presented by the great limestone mesas beyond Blue Goose Prairie. Polished and striated masses of pre-Cambrian crystalline rocks, exhibiting all the signs of intense denudation by a continental ice sheet, end abruptly against a high, flat, utterly barren mesa. So rapid has been the weathering of the limestone that the highland

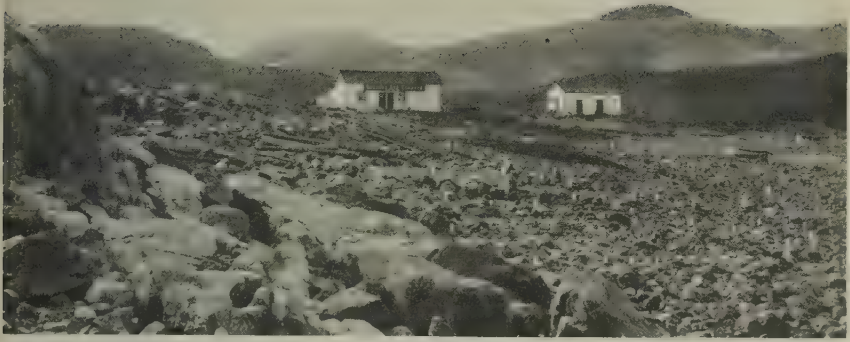

FIG. 30

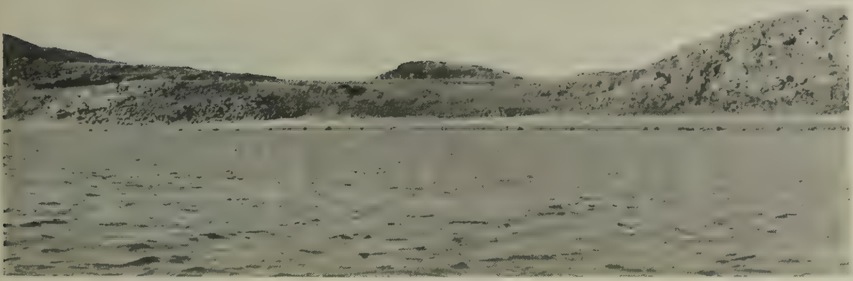

FIG. 31

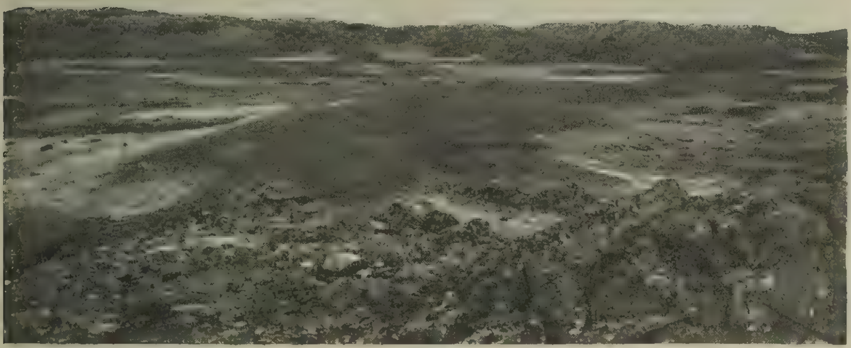

FIG. 32

FIG. 30—Hudson's Bay Company post at Cape Dorset.
FIG. 31—Terrace at 60 feet across the bay from Cape Dorset.
FIG. 32—One of the countless raised beaches of northern Foxe Land, inland from Camp Walcott.

exhibits no evidence of having ever been glaciated, yet there is no reason to suppose that it was not completely covered by the same ice sheet that so profoundly changed the adjacent terrain. The canyons that cut across it are steep-walled and generally have wide flat bottoms strewn with boulders. At the time of our visit these canyons were occupied only by small streams and ended at the edge of the mesa in alluvial fans across which the streams dwindle or are completely absorbed. The stream from the fifth canyon (see Fig. 33) is the largest and is the only one that reaches the prairie with any degree of the volume it possesses within its canyon.

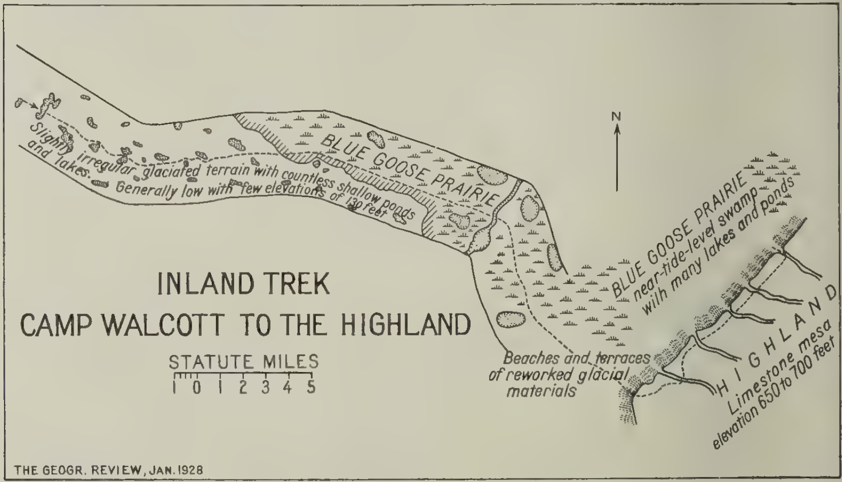
Slightly irregular glaciated terrain with countless shallow ponds and lakes. Generally low with few elevations of 130 feet
BLUE GOOSE PRAIRIE
N
BLUE GOOSE PRAIRIE near-tide-level swamp with many lakes and ponds
INLAND TREK
CAMP WALCOTT TO THE HIGHLAND
STATUTE MILES
1 0 1 2 3 4 5
Beaches and terraces of reworked glacial materials
HIGHLAND
Limestone mesa elevation 650 to 700 feet
THE GEOGR. REVIEW, JAN. 1928

FIG. 33—Map showing the character of the terrain crossed in the trek from Camp Walcott to the highland.

The mesa profiles of the highland are due to the fact that the topmost 30 to 50 feet of the limestone composing them is considerably more resistant to weathering and erosion than the underlying strata. Not that the cap rock is notably resistant, for it is a very porous nodular limestone often conspicuously jointed, but the underlying beds are mainly a blue-gray, fissile calcareous shale which weathers with extreme rapidity. Where exposed without the more resistant cover rock the shale becomes gullied into a sort of miniature badland relief. Irregularly disposed through it are strata of limestone like the cap rock; and where the canyons cross are rapids or cascades. Here, then, in these highlands a landscape has developed, not under conditions of special aridity which one associates with its mesa form, but rather by intensive frost action under ideal conditions of no vegetation and advantageous rock structures. Furthermore, it is only recently that the foot of the north façade of the highland was washed by the waters of Foxe Basin. The rapid cutting by the waves in the weak shales below the harder cap rock has apparently been a very important factor, for the sharp profiles of the mesas are restricted to this side of the highland.

Where the coast trends northward the topographic expression of this sedimentary formation is that of an extensive plain so utterly flat that its slope is imperceptible. Likewise with an equally flat gradient it passes beneath the waters of Foxe Basin where it is covered with soft calcareous mud. A vertical fluctuation in the tides, as great as thirty feet in places, exposes muddy tidal flats of extraordinary width, whereon ripple marks bear testimony to the strong currents developed by the changing tides.

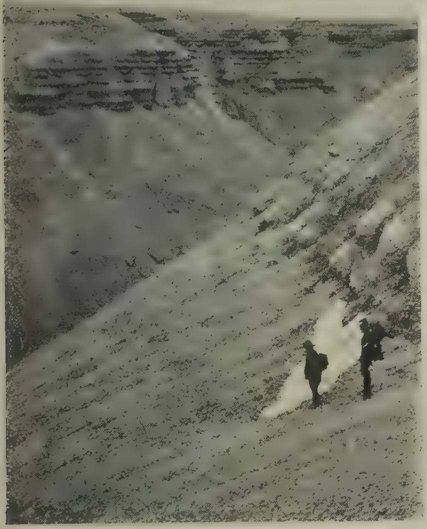
FIG. 34

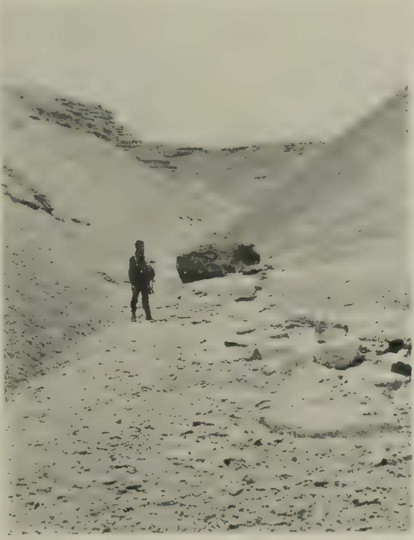
FIG. 35

FIG. 34—Descending into one of the canyons of the highland, 50 miles inland from the southeastern extremity of Foxe Basin.

FIG. 35—Bottom of one of the canyons of the highland where many fossils were found.

The floor of the southeastern bay of Foxe Basin is composed of the old basement complex of pre-Cambrian rocks so that the limestones and shales exhibit practically their entire thickness in the mesas of the highland. This occurrence, further, probably represents a maximum thickness for this formation; for to the north it is represented by only a few feet of strata unless there is an abrupt and even precipitous change in the slope of the underlying pre-Cambrian rocks, and this seems entirely unlikely. The western limits of this formation are clear-cut, as indicated on the geological map. We did not penetrate far enough inland to reach its southern limits; but the contact with the older rocks below does not seem to be far north of the head of Chorkbak Inlet, for fragments of limestone apparently transported by water and but little worn and containing fossils like those of the highland were found near the head of this great fiord. These sedimentaries are probably of Ordovician age.[26]

The nature of the eastern shore of Foxe Basin had already been deduced from Eskimo information and the presumed extension of the Lower Paleozoic limestones west of Lake Nettilling. Bell, writing in 1898, said:

> The scanty information we possess goes to show that Fox Basin is partly bordered on both sides by comparatively low land occupied by undisturbed fossiliferous Silurian limestone. Dr. Franz Boas ascertained the existence of these limestones on Lake Nettilling and he states that southward of the lake they rise into low hill-ranges. He also says: 'We will not be far astray if we connect this extensive Silurian district with the limestones which occur to the south of Igluling and which form the flat eastern half of Melville Peninsula. . . . It must be important for the problems of glaciation to survey the *inner* rim of the enormous basin formed by the chain of mountains of Davis Strait, the plateaus of Nugumit, Kingnait, Sikosuilat, Southampton Islands and Melville Peninsula.'[27]

Comparison may be made with the low limestone coast of the eastern side of Melville Peninsula explored by the Fifth Thule Expedition, in part "so low that one could hardly tell positively whether one was on the ocean ice or on land at a time when everything was covered with snow."[28]

Our first actual knowledge of the eastern coast of Foxe Basin is due to Bernhard Hantzsch. He explored northward from the mouth of the Koukjuak River for a distance of about 250 miles by sledge to a point in latitude 68° 45′. According to his account[29] the character of this stretch of coast is about as follows:

> Near the mouth of the Koukjuak the coast is entirely flat. A little beyond to the north boulder ramparts about 6 to 9 feet high parallel the coast and also occur farther inland. The shore line itself is in part exceedingly sinuous, in part smooth and without major indentations. Farther north the character of the coastal belt changes completely. Gneiss or granite hills interrupt the coastal plain more and more frequently. In places these hills abut almost directly on the shore, elsewhere they leave a foreshore over a mile wide. Their margins are often dissected by elongated lake-filled valleys. They are 30 to 50 feet high, increasing to 180–250 feet in the north.
>
> Offshore the coast is bordered in places by numerous rocky islets and reefs rarely exceeding 30 feet in height. North of about latitude 67½°, however, the offshore islands increase in size and height, a group of especially large islands lying abreast of the shore between 68° 20′ and 68° 45′. In general these islands are 120–250 feet high, although elevations of 300–350 feet and even of 450–600 feet occur.
>
> Inland the terrain increases in elevation as one goes northwards. Near the Koukjuak it is still low, although undulating. Limestone boulder ramparts 10–15

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[26] The fossil collections are not yet in hand for study, but enough forms were recognizable in the field to indicate the probable age. More cephalopod genera were found than any other types, though the easily recognized gastroped Maclurea was the commonest single form. Bryozoa, brachiopods, corals, and a few trilobites were also collected.

[27] Bell, *op. cit.*, p. 17M.

[28] Knud Rasmussen and Associates: The Danish Ethnographic and Geographic Expedition to Arctic America, *Geogr. Rev.*, Vol. 15, 1925, pp. 521–562; reference on p. 556.

[29] Rosenmüller, *op. cit.*, especially pp. 705–715.

feet high, sometimes 30–35 feet high, and gneiss ridges 20–25 feet high here cover the ground. Gradually the land rises, but for a time the level character of the landscape is maintained inland as on the coast because of the predominance of plains both large and small. From latitude 67½° on, at which point a wide river debouches, high, long, steep-sided, and flat-topped ridges are visible inland on the horizon. At first they are 300–600 feet high, but farther north they seem to attain as much as 1500 feet. Deep valleys and gorges, often occupied by lakes, dissect them. In the last part of the journey, say north of 68°, the ridges decrease in height and their upland surfaces are more rounded; only their abrupt slope on the seaward side remains characteristic of this region. The rocks are predominantly crystalline, although some limestone occurs. Far to the north large areas are evidently covered by an ice cap.

Glaciation and Post-Glacial Emergence

To one who is familiar with the polished, striated, and grooved forms that abound in the glaciated areas of the Great Lakes and central Canada, the rocks of Baffin Island seem peculiarly devoid of such markings. One's first impression is that the glaciation must have been more ancient here than in the northeastern United States and Canada. There is still too little information available to demonstrate that such is not the case. The conspicuous paucity of fresh glacial markings is most notable along the coast, but even inland to such distances as the head of Chorkbak Inlet, evidences of glaciation are not prolific.[30] The cumulative effects of frost action on the totally unprotected rock surfaces have apparently been very great in postglacial time and have largely eliminated the shallower striations and grooves. On the greatly flattened surfaces along the north-central coast of Foxe Land, however, striations and chatter marks are more common. One must, however, be cautious in interpreting them. Great masses of débris-laden ice are pushed up onto the flat shores by rising tides and often shoved along on the rocks for considerable distances. Scratches identical in appearance with true glacial striations are thus produced, a process seen in actual operation. It does not seem probable that sufficiently large masses of ice could be moved in this fashion so as to form chatter marks, and it was these markings that were sought along this coast in attempts to decipher the directions of ice movement of glacial time. One gathers from a study of such directions that the ice which denuded Foxe Land came from a center to the north and east—some place perhaps north of Nettilling Lake, where according to Eskimo accounts there is still a large ice cap.

From Big Island to Cape Dorset, whenever the mainland was in view, there were few times when the horizon of monotonously rounded forms of glacial origin was not broken by the even profiles of old strand lines. So few stops were made that it was not possible to ascertain the altitudes of most of these old beaches or terraces. None were noted at heights even approximating those of the highest hills. Bell determined the elevation of a number of the terraces along this stretch of coast. He found that altitudes as great as 400 feet were not uncommon and notes one terrace at 528 feet.[31] Amadjuak is built upon one of such a series of terraces. The Hudson's Bay Company post at Cape Dorset is likewise on a former beach scarcely 25 feet above present sea level, and directly across the bay from it is a pronounced terrace at 60 feet (Fig. 31). But it is along the more favorably located parts of the north coast of Foxe Land that these remnants of former shore lines are particularly numerous and surprisingly new.

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[30] Bell, *op. cit.*, p. 29M.

It seemed that all over Cape Dorchester, wherever there had been a secluded zone, beaches had been developed at nearly all levels. The fresh unweathered character of the sub-angular pebbles that compose them is striking. Twenty feet above sea level on the south side of the Cape is a beach in which the pebbles are as loose and as unweathered in appearance as those of the beach in process of formation immediately below.

Along the central part of this coast of Foxe Land, where the land is so flat over great areas, there is an almost total absence of beach forms, either present or ancient, simply because there have been no places for them to establish themselves. But within the relatively more rugged region about Camp Walcott, beaches, bars, and spits of former levels are numerous. The camp itself was located on a beach but newly raised from the sea. The most extensive terraces noted are developed from reworked glacial clays and abut on the highland on the west. Below these terraces there are at least two distinct beach levels between the foot of the highland and Blue Goose Prairie. From the rim of the mesa one looks down to the north to see a double series of undistributed bars or barriers with hooked spits impounding elongate lagoon-like lakes. At no place along the coast does the period of uplift appear to have been more recent than here.

It is evident that the raised beaches and associated forms are neither persistent enough nor widely enough developed to give a definite measure as to the maximum amount of uplift. Daly[32] and others who have made extensive physiographic studies in arctic or subarctic lands have worked on the principle that on propitiously situated hills or forelands on a glaciated shore where the surf from the open ocean could be felt, the existing lower limit of undisturbed glacial erratics marks the highest limit at which the sea has existed since glacial time. Our progress along the south coast was too fast to make out any definite, continuous, boulderless zones or accordant,

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[31] Bell, *op. cit.*, p. 30M.

[32] R. A. Daly: The Geology of the Northeast Coast of Labrador, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 38 (Geol. Ser., Vol. 5), 1902, pp. 203–270.

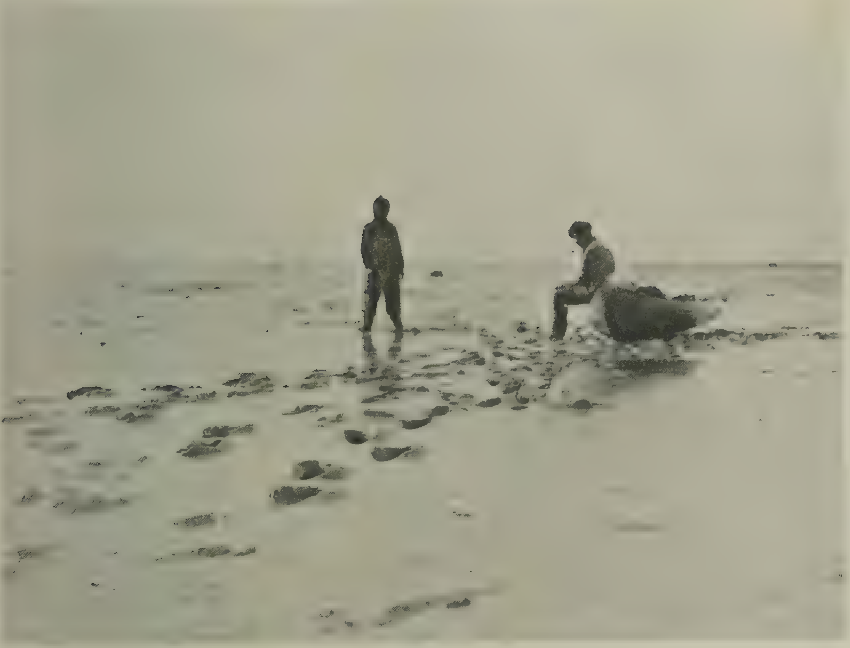

Fig. 36

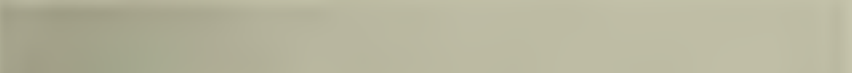

Fig. 37

Fig. 36—West coast of central Baffin Island. The mud flats, at low tide, reach out five miles and more from the shore line.

Fig. 37—The desolate reaches of mud, gravel, and grass, utterly level, characteristic of the western Baffin Island coast south from the mouth of the Koukjuak River.

undisturbed, boulder-covered heights. But where we penetrated inland by way of Chorkbak Inlet the paucity or total absence of balancing rocks and erratics on the hills and even on gentler slopes was noteworthy.

In the whole reach of the coast from Cape Dorchester to the eastern limits of Foxe Basin no recognizable undisturbed glacial or fluvio-glacial deposits were found—no plaster of glacial clays even on the flattest rocks, such as one finds, for instance, in the Holstensborg hinterland of Greenland and such as one might expect to find in a region so recently glaciated as this one probably has been. In all of our inland treks along this coast no balancing rocks were observed, and erratics were conspicuously scarce on the few gentle hills and knobs that rise above the general level. It was our custom to build cairns for markers on the higher knobs as we journeyed inland, and we always found it necessary to carry up the rocks for this purpose from lower levels.

If we suppose a line drawn from the head of Chorkbak Inlet northward along the western side of the highland formation to be the eastern boundary of Foxe Land, then one's impression of this land as a whole is that the southern coastal zone is the highest part and that it gradually flattens toward the north to pass beneath the waters of Foxe Basin with the flat gradient already noted. A large part of Foxe Land is then structurally or physiographically a part of Foxe Basin and may have arisen from a condition of almost if not quite complete submergence in postglacial times. This conclusion is entirely legitimate if the amount of uplift here is at all of the order of that of Mill Island which lies but 25 miles to the south of the mainland and where well-defined beaches are found at elevations of 500 feet above sea level.

One has but to note the present appearance of the northern shores of Foxe Land and the coast trending northward from the great southeastern bay with its unbelievably wide tidal flats, to vizualize how great areas of Baffin Island have but recently been born and how the process is still in operation.

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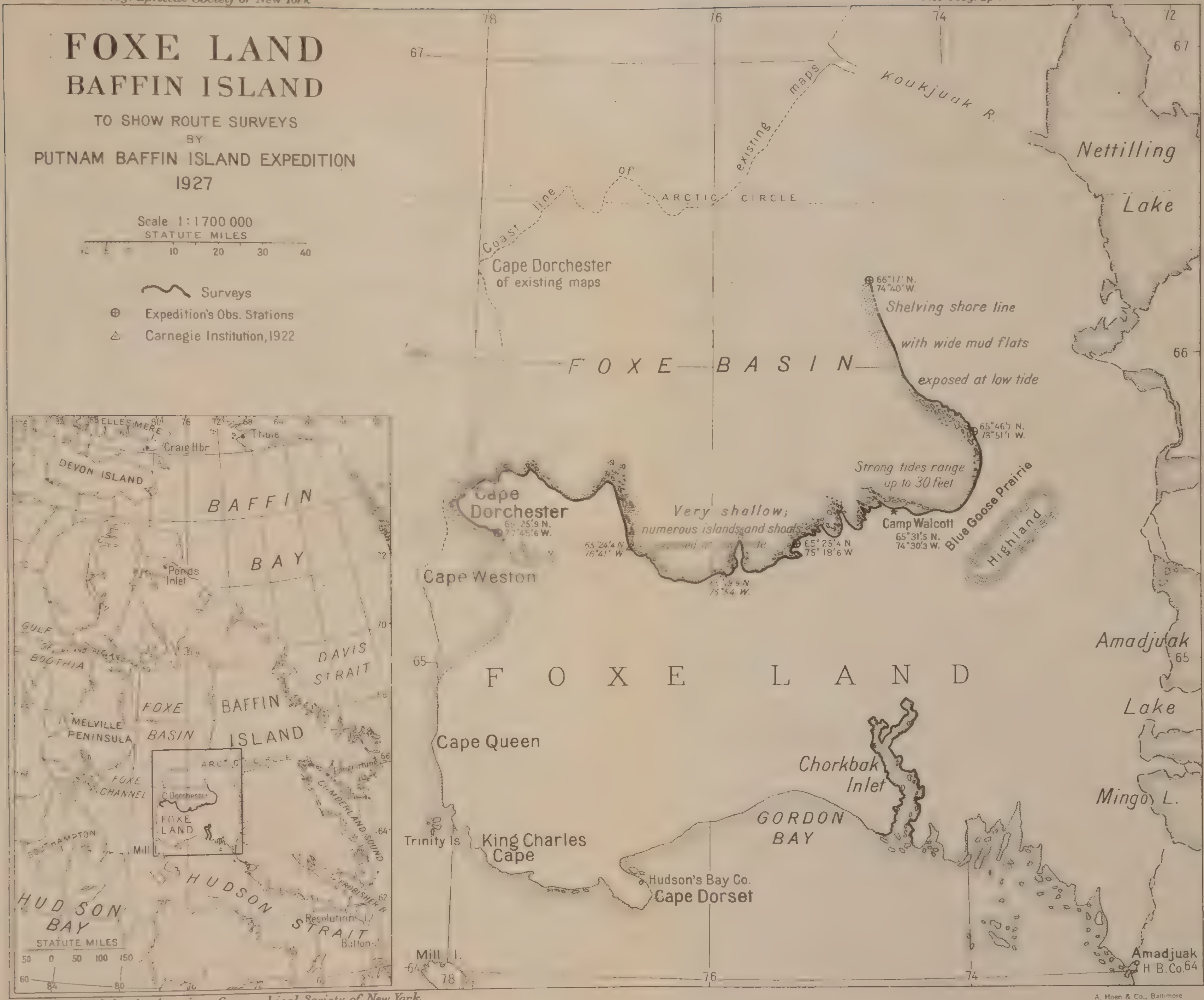

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THE RENAISSANCE OF ICELAND

Earl Hanson

ON May Day last year (1927) I witnessed a labor demonstration in Reykjavík. Some three hundred men and women marched down the street carrying red flags and communistic banners, singing the International. It was the sign of a new Iceland. Even at the time of my first visit in 1920 the country had had no experience whatever with labor trouble.

Paradoxically enough, labor trouble in Iceland is a sign of progress, of reorganization and growth, economically, financially, politically. A profound change is coming over the life of the nation. For centuries Iceland has been effectually cut off from the rest of the world, "a backwater of civilization.[1]" They were bitter centuries, and their lesson has been well learned. Iceland today is finding its salvation by becoming a part of our world organization of interdependent units. Here is a group of people, about equal in point of numbers to the population of Knoxville, Tennessee, carrying out or about to carry out most of the functions of a modern nation in times of peace. Whether or not the nation will ever be a very important unit is immaterial. The importance to the Icelanders is enormous.

ICELAND AS A TESTING GROUND

Any change that takes place in Iceland is worth watching. Nowhere else in the white man's world do we find the same purity of conditions, the same opportunities for studying the life of modern man or for the testing of social theories, from the Malthusian to the Marxian. For here is a group small enough for convenient observation and yet large enough and diversified enough to be taken as a unit, demonstrating most of the processes and factors that enter into our complex life. One important item is lacking in the list—warfare and its attendant preparedness. Iceland gained its independence less than a decade ago without shedding one drop of blood: she has not a vestige of an army and has only three small fishing patrols for a navy. But this lack in itself opens a unique opportunity for study to the economist, not to mention the pacifist and the militarist. And we can observe the changes in the life of a people that come with the "modernization" of their country and a readjustment of economic

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[1] In the *Geographical Journal* for July, 1927 (p. 49), Mr. J. H. Reynolds says: "It seems inevitable that Iceland must always remain a backwater of civilization"; but his paper comparing Iceland in 1872 and 1926 shows the remarkable progress made in the island.

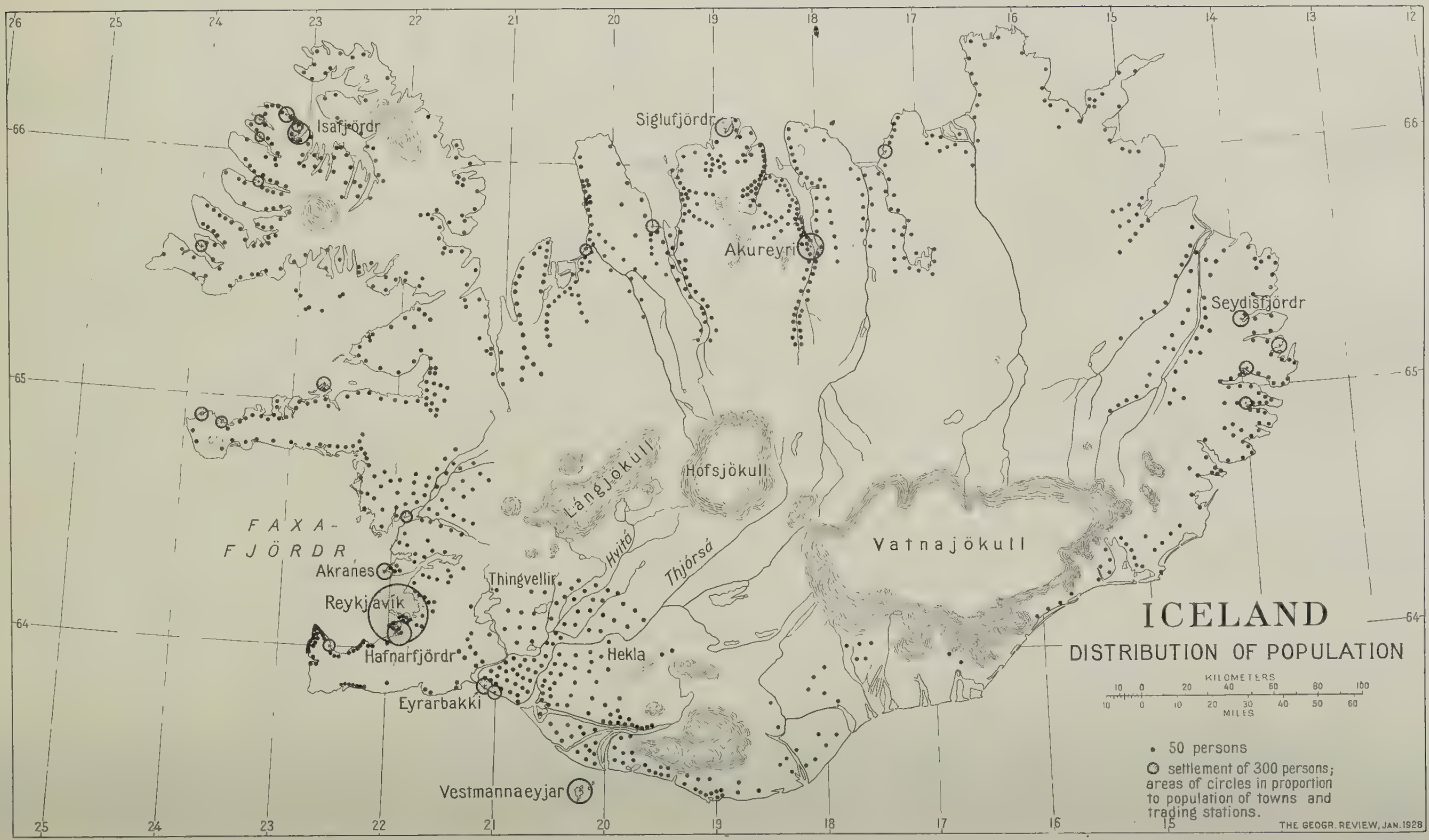

FIG. 1—Map showing the distribution of the population of Iceland. Data from the census of 1920. In the placing of the dots use was made of Gunnlaugsson's map of 1844, scale 1:480,000, which shows towns, trading settlements, and farmhouses. There has been little change in the inhabited area since this date, though administrative divisions have been changed. Where available the excellent sheets of the Topographical Section of the Danish General Staff, scale 1:50,000, and new series, 1:100,000, have been consulted. The complicated nature of the seasonal shifting of the fishing population, affecting some 18,700 people, does not permit representation on this map (compare Söderlund's Population Map of Norway, 1922). Scale of map, 1:3,500,000.

conditions, hygienic changes, growth of population, shifts in population, and later undoubtedly the more subtle changes in racial characteristics, physical as well as psychological.

The Icelanders are a homogeneous people, speaking one language without dialects.[2] Population numbers have remained unaffected for a thousand years by immigration and, except for the last decades of the nineteenth century and the first few years of the twentieth, by emigration.[3] Racial characteristics have developed through a millennium of effective isolation, uninfluenced by "new" or "foreign" blood. And even the original stock of the population is open to study. The "Landnámabók," the Book of Settlements, lists many of the more important settlers who came to the island in the ninth and tenth centuries, giving names, places of settlement, locations of their old homes, and in many cases even genealogies. Most of these settlers were Norwegian or at least Scandinavian. Some question can be raised as to the number that came from Britain. Professor Hannesson estimates it at thirteen per cent, pointing out that of these too a certain number were undoubtedly Scandinavians.[4] Others estimate the Celtic percentage at about twenty-five. Jon Stefansson states that fully one half of the settlers came from the British Isles and goes so far as to call Iceland a British colony.[5]

THE HISTORICAL BACKGROUND[6] AND THE POPULATION CURVE

During the eighteenth century Iceland was stagnating, indeed at times was on the verge of extermination. The primary cause is simple—the trade monopoly of the Danish government. The island was Danish territory, with practically no voice whatever in the management of its own affairs. All trade in the country was either carried on by the state or leased to private individuals in Denmark, much as is the trade in Greenland today. Heavy punishments were inflicted on Icelanders who infringed the monopoly by occasional barter with "foreigners," Englishmen or Germans. The condition was not a healthy one. The Danish merchants did not make much money out of poverty-stricken Iceland. Imported articles, lacking the stimulus of competition, were often of inferior quality. Flour was wormy, timber rotten. The country could not thrive without trade. The land itself offered too few natural resources. Little was grown but hay, which was turned into meat and wool and dairy products. There was no grain, no timber, no coal, no iron. All of these products, necessary to the life of civilized man, had to be imported in exchange for fish.

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[2] Old Norse. "The Icelanders can read and understand their literature of the twelfth and thirteenth centuries much more easily than an Englishman can the works of Shakespeare." See "Iceland," published 1926 by the National Bank of Iceland and reviewed in this number of the *Geographical Review*.

[3] Icelanders and those of Icelandic descent in North America number some 25,000.

[4] Gundmundur Hannesson: Körpermasze und Körperproportionen der Isländer: Ein Beitrag zur Anthropologie Islands, Reykjavík, 1925, p. 6.

[5] Jon Stefansson: Iceland: Its History and Inhabitants. *Ann. Rept. Smithsonian Instn. for 1906*, pp. 275–294; reference on pp. 287–288.

[6] Knut Gjerset: History of Iceland, New York, 1924.

Under such circumstances any unfavorable event was a catastrophe, and catastrophes occurred in plenty. The Icelanders were decimated by earthquakes and volcanic eruptions, by famines, by epidemics. In three years (1782–1785) Iceland lost almost one-quarter of her population (Fig. 2). It was during this period of misery that the first steps were taken toward the emancipation of the country, political as well as economic. One after the other of the Danish merchants who held the Iceland concessions failed. An incessant lament and wail of protest went up from the Icelanders themselves. The monopoly was partially abolished by ordinances of 1786 and 1787, and trade in Iceland was thrown open to all Dano-Norwegian subjects.

The behavior at this time of the population curve is of extreme interest. No definite figures on population are available before the year 1670, although it has been calculated at over 70,000 in the early fifteenth century.[7] In 1670 it stood at 50,000, in 1703 at 50,444. The curve swings up and down with violent vibrations. Iceland was pointed out as proof of the theory that populations, when left to themselves, do not grow. In the country itself there was a superstition that 50,000 was an unlucky number—reaching it was a signal for another of God's many vengeances on a stricken people. But with the lifting of the trade monopoly the population curve takes on a smoother aspect, the downward swings are shallower and less abrupt, the curve staggers upward toward the 50,000 mark and passes it in 1832, probably never to return.

The partial lifting of the trade monopoly, however, was not entirely a success as far as either Iceland or the mother country was concerned. In the early part of the nineteenth century Denmark became actively involved in the general Napoleonic turmoil and could pay little attention to her isolated colony. British and even American traders gained some headway in Iceland, but the island still suffered from lack of competitive trade.

One important factor attended the improvement, slight as it was, in Iceland's national health. The spirit of nationalism, caught from that general zeal for liberty which spread over the whole western world, took a strong hold.

The nineteenth century was marked by a gradual political and economic emancipation. The Althing, the general assembly for the whole island, established in 930, was restored in Reykjavík in 1843. During the eighteenth century it had struggled on impotently at Thingvellir, until finally abolished in 1800. In 1848 the first weekly paper was issued. In 1854, as the result of a petition to the Danish government, the trade monopoly was entirely abolished, and Iceland was thrown open to all nationalities with immediate beneficial results.

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[7] Hannesson, *op. cit.*, p. 30.

In 1874 Iceland received its first constitution. In 1904 the country got home rule, in 1918 complete independence. Today Iceland is a free and sovereign kingdom united with Denmark by a common king.[8]

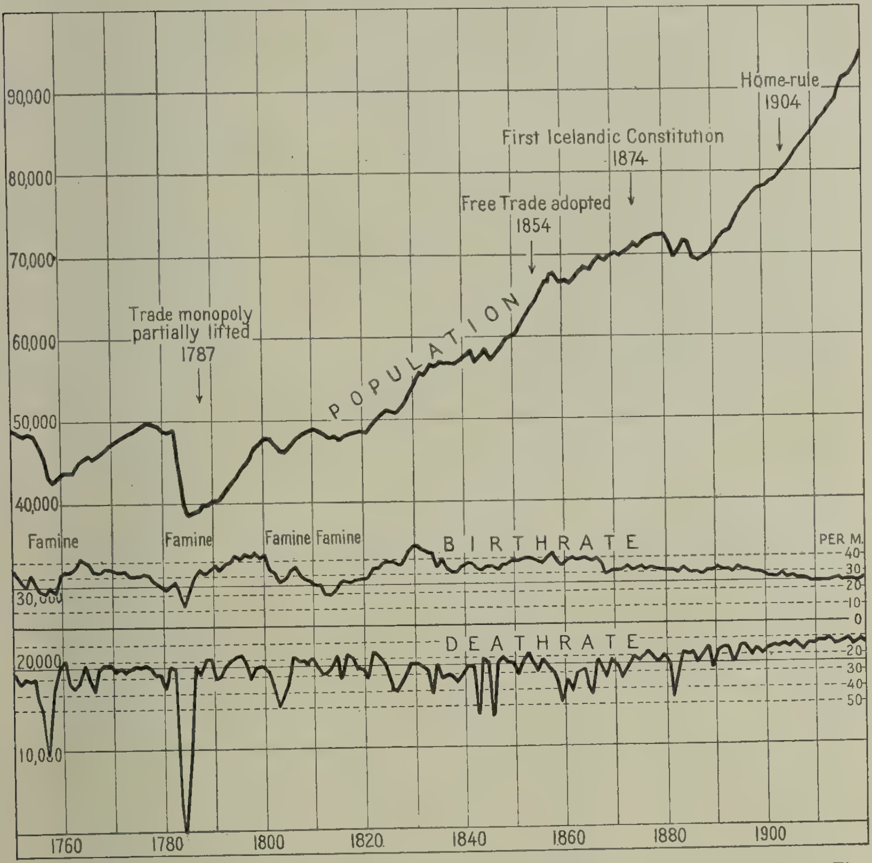

FIG. 2—Graph showing the movement of the Icelandic population from 1751 to 1920. (From Fig. 1 of Gudmundur Hannesson: Körpermasze und Körperproportionen der Isländer, Reyjkavík, 1925.)

So far has the country's spirit progressed in the last century that today the question of imperialism is beginning to show itself. A small but determined group is demanding access to and eventual possession of Greenland. It bases its claims on "historical" as well as "natural" rights—the first centered on the early discovery and colonization of Greenland by Icelanders, the second on the fact that Iceland has more use for the rich Greenland fisheries than has Denmark, these now being withheld for the purpose of protecting some 14,000 Eskimos. All Danish subjects, it should be noted, have equal rights with the Icelanders as far as access to Icelandic fisheries is concerned. In 1918, when the Dano-Icelandic Act of Union was drawn up, the Icelanders protested that this arrangement was more favorable to Denmark than Iceland and requested that the Greenland fisheries be thrown open at least to Danes and Icelanders. In the motifs of the Act is a paragraph stating that this will be done as soon as possible, but that it is impossible under the present conditions.

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[8] A summary of the Act of Union is given in Gjerset, *op. cit.*, pp. 449–451, and in "Iceland" pp. 23–25.

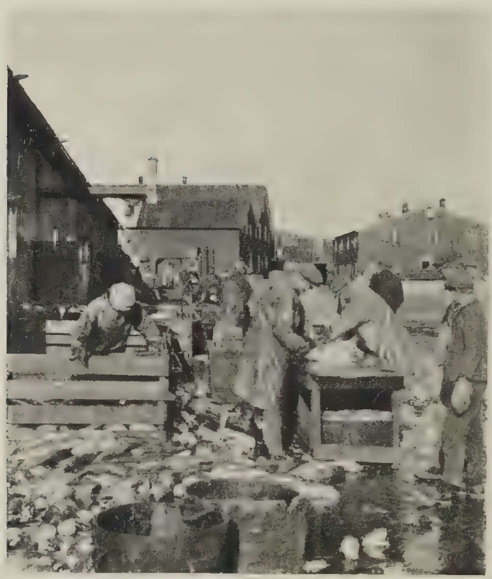
FIG. 3—Shore crews of large motor boats cleaning fish at Sandgerdi.

CHANGES IN THE TWENTIETH CENTURY

It is held by many that modern Iceland was born with the twentieth century. Certainly most of the visible changes which today distinguish the country from that of two hundred years ago were made in the last twenty-five years. The Bank of Iceland was established in 1902, the telegraphic cable to the British Isles and the European mainland was laid in 1906. The first telegraph line was built about the same time. The building of roads was begun in 1894. The University in Reykjavík was founded in 1911. The Icelandic Steamship Company was established in 1914, and the Icelandic Marine Insurance Company in 1918. Agricultural schools, business schools, marine schools were founded. Trade and commerce boomed. In 1912 there were fifteen wholesale dealers and commission agents in Iceland; in 1923 there were 48. The first permanent daily paper was established in 1911: today there are three dailies, besides eleven weeklies. There are, moreover, quite a number of periodicals, some literary and general, others devoted to special subjects, commercial magazines, an engineering paper, periodicals on fishing and farming, medicine, theology, etc. The splendid harbor works at Reykjavík are of recent origin.

THE ECONOMIC PROGRAM: THE FISHERIES

In an interview with the prime minister of the time, Mr. Jon Thorlaksson, I asked whether the rebuilding of Iceland is being worked out in accordance with a definite plan, an economic program. The answer was that no such program has been drawn up but that the general trend may be expressed as follows: (1) improvement and expansion of the two main branches of activity—fishery and agriculture; (2) establishment and expansion of foreign commerce with a permanently favorable balance of trade; (3) the possible future establishment of manufacturing industry, utilizing the enormous but hitherto untapped natural resources—water power and natural steam.

TABLE I—COMPOSITION OF THE ICELANDIC FISHING FLEET

<table>
<tr><th>YEAR</th><th>SAILING VESSELS</th><th>MOTOR BOATS OVER 12 TONS</th><th>TRAWLERS</th><th>OTHER STEAMERS</th><th>MOTOR BOATS UNDER 12 TONS</th><th>ROWBOATS</th></tr>
<tr><td>1905</td><td colspan="2">165</td><td>1</td><td>3</td><td colspan="2">1944</td></tr>
<tr><td>1910</td><td colspan="2">140</td><td>6</td><td>2</td><td colspan="2">1724</td></tr>
<tr><td>1915</td><td>95</td><td>40</td><td>20</td><td>6</td><td>391</td><td>1121</td></tr>
<tr><td>1920</td><td>39</td><td>120</td><td>28</td><td>2</td><td>355</td><td>1002</td></tr>
<tr><td>1921</td><td>33</td><td>124</td><td>28</td><td>1</td><td>340</td><td>992</td></tr>
<tr><td>1922</td><td>41</td><td>140</td><td>31</td><td>6</td><td>354</td><td>901</td></tr>
</table>

It is natural that the effects should be most immediate as regards the fisheries. After a thousand years of existence Iceland is in many respects just emerging from the pioneer stage. Transportation facilities on land are still lacking. The fishing grounds, however, are immediately accessible. The government's activities are mainly concerned with police, education, and encouragement. Three gunboats patrol the fishing waters in an effort to keep all trawlers and all foreign fishermen outside of the three-mile limit.

One-third of the "profits" of the patrol boats, fines, and proceeds from the sale of confiscated materials are put into a national fund for the promotion of fisheries, a fund which is augmented by direct governmental subsidies. Loans from it are granted for the purchase of vessels and fishing gear and for any kind of improvement in the fishing trade. Sums are granted to young men who desire to study the fishing industry abroad. Certain sums are used for the publication of periodicals that deal with fishing. Others are given out as rewards for exceptional merit. The government, moreover, runs two special schools for sailors and fishermen, one for navigation opened in 1891 and the other for marine engineers opened in 1905.

The changes that have taken place in recent years in the nation's fishing methods are strikingly demonstrated by the accompanying table. Large motor boats and steam trawlers—the latter constituting nearly two-thirds the total tonnage in 1922—are taking the places of rowboats.

In the movement of population, discussed later, this has a special significance. While fishing has always been one of the chief occupations of the Icelanders, it is now becoming a highly specialized occupation. Almost any farmer can fish from a rowboat at certain times of the year, but it takes all of a man's time and energy to belong to the crew of a trawler or a large motor boat. Farming and fishing are definitely being divorced from each other—the latter now calls for concentration of population at the ports and coastal towns, where the catch can be handled, salted, dried, packed, and shipped in large quantities.

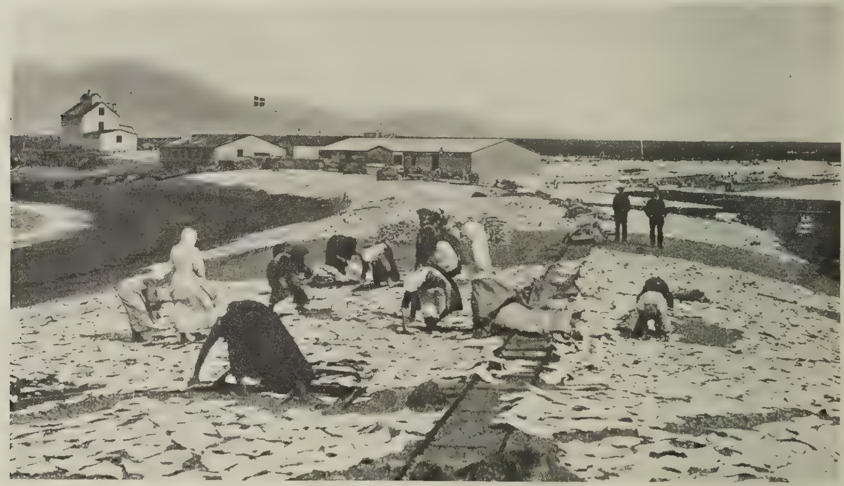

FIG. 4—Spreading codfish in the sun to dry. (Photograph by Magnus Olafsson.)

An enormous increase in the catches of the last few years is evident in the government statistics. Some fifteen million cod and fish of the cod species were caught in 1900. In 1922 the number had risen to thirty-six million. The herring catch has increased proportionately. In 1923 the export of herring amounted to 19,000 tons, the total export of fish to 59,464 tons.[9] By far the greater part of the fish are exported salted or salted and dried. Some are sent to England packed in ice. Canneries are being talked of: a few were established immediately after the war, at the time of the country's greatest prosperity; but these failed, partly because of inexperience, both in canning and in opening new markets. But there is hardly any doubt that large fish canneries will in the future help to stabilize the export trade.

One extremely interesting phase of the fishing life is the coöperative system employed in connection with the large motor boats engaged in fishing for cod. Ten men comprise the crew of each boat—five belong to the shore crew and five to the boat crew proper. At the coastal fishing stations, each crew of ten lives in one room of a dormitory, sharing the room with a servant-girl who is hired by them to do the cooking.

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[9] Figures from "Iceland."

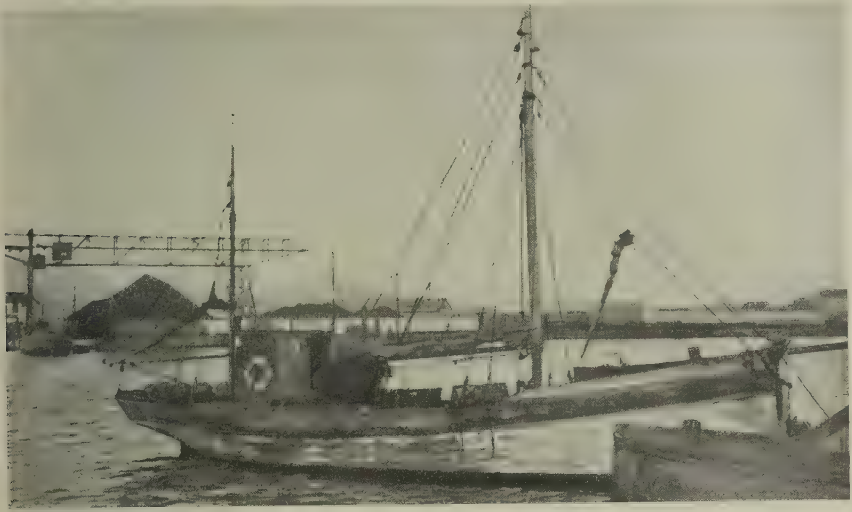

FIG. 5—Twelve-ton motor boat used extensively for fishing, Reykjavik harbor. Note the modern coal crane in background, built in 1927.

The shore crew cleans fish, boils the livers, etc., and also prepares the lines and baits the hooks. The boat crew goes to sea fourteen to eighteen hours at a time and fishes with set lines. None of the men receives wages. They buy their food coöperatively at the station's store and generally charge the cost until the end of the season. When the season at any one station is closed, the proceeds are divided as follows: the owner of the station receives one-twenty-fifth for the use of docks, sheds, living quarters, etc. The remainder is divided into twenty parts, of which the owner of the boat receives nine, the captain receives two, and each man receives one. The owner of the boat pays for lines and hooks, also for half of the engine oil and half of the bait (generally pieces of fresh herring). The others each pay for one-twentieth of the oil and bait.

The engineer receives his twentieth of the total catch and also has a private line for which he buys the bait and the full proceeds of which go to him. Salt is paid for on the same basis as oil and bait.

The cod liver oil belongs to the men, but the heads go to the owners, who first spread them out to dry and to fertilize the land and later grind them up for fish meal. If prices are low at the end of the season, the men have the option of taking their share in fish instead of money or of storing the fish on the chance of a rise in prices. In this manner a fisherman may earn anywhere from $70.00 to $700.00 for a season's work.

Promotion of Agriculture

There is as much significance as picturesqueness in the fact that many of the government's agricultural statistics are still expressed in terms of horseloads. The crying need of Icelandic agriculture is transportation. Little can be done where the produce must be carried to market on ponyback. There is not a single navigable river in the country. The need is being met as fast as the limited national finances will allow. Some half a million *krónur* a year are being spent on the building and upkeep of bridges and roads. At the beginning of the century the sum was about a hundred thousand. In 1890 there were no cart roads whatever in Iceland; today there are some 1500 kilometers, most of them suitable for automobile traffic and radiating from the principal towns. Only now has construction begun to connect the towns. In six years it will be possible to motor from Reykjavík to Akureyri.

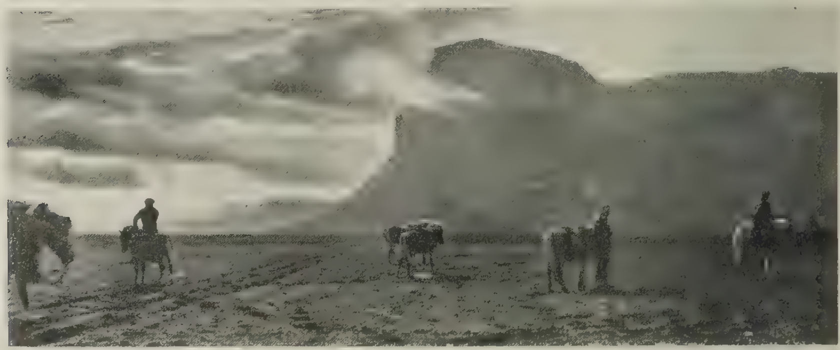

Fig. 6—Icelandic ponies. While in Iceland they are gradually being supplanted by automobiles for travel purposes, they are nevertheless increasing in numbers, owing in part to increasing exportation (see Fig. 15). (Photograph by Olafur Magnússon.)

For many years there has been talk of railroads, but the necessary capital has been lacking. A water-power concession was granted last year (1927) to a Norwegian company, with the express stipulation that the company also build a sixty-mile railroad from Reykjavík into Iceland's richest agricultural district. According to the terms of the concession, work on this railroad must be begun by May 1, 1929; but at the present writing the stocks of the company are low, and there is great skepticism in Iceland as to whether or not the road will be built.

The term "agriculture" in Iceland is not to be taken with the same meaning as in more southerly countries. Cereals cannot be grown. There are no large plowed fields. A clump of houses with a small patch of potatoes and turnips, a fairly large fenced field, manured or fertilized with nitrates and phosphates, growing soft rich hay, and wide, open pasture lands on which the sheep and the horses and the cows can stray far into the hills—that is an Icelandic farm. More often than not the land is broken up by hummocks, the bane of the Icelandic farmer. Machines—tractors—are almost never seen, even horse drawn plows were a rarity until ten years ago, and only now are mowers and wheeled rakes being introduced in those localities where the nature of the ground and the means of the farmers will permit of their use. But if the means are limited, they are being energetically developed. Well over a hundred farmers' coöperative societies now receive government aid for the promotion of agriculture. The government itself runs two agricultural schools and experimental stations and makes direct loans out of the agricultural fund for the improvement of estates and living quarters.

FIG. 7—Írafoss, on the Sog River, flowing from Lake Thingvalla. (Photograph by Hans Petersen.)

An act of the Althing of 1903 provides for an annual grant of 100,000 *krónur* to be expended on barbed wire fences and thus allow for more intense cultivation of hayfields. For it is in hay and its animal products that the salvation of Icelandic agriculture lies. It is claimed that the rich lowlands of southern Iceland, if properly developed for dairying, could support the entire present population of the country.[10] Coöperative dairies are springing up. Icelandic butter and cheese are finding their way into the British market, where they are meeting with a very favorable reception.

Sheep and horses, through the centuries of the country's isolation, have developed into distinct breeds. Both are small and hardy, a fact which is more to the advantage of the latter than the former. One has but to pick up almost any travel book on Iceland, whether sympathetic to the country or not, to find the horses eulogized.[11]

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[10] Gjerset, *op. cit.*, pp. 453–454.

[11] See, for instance, W. S. C. Russell: Iceland: Horseback Tours in Saga Land, Boston, 1914.

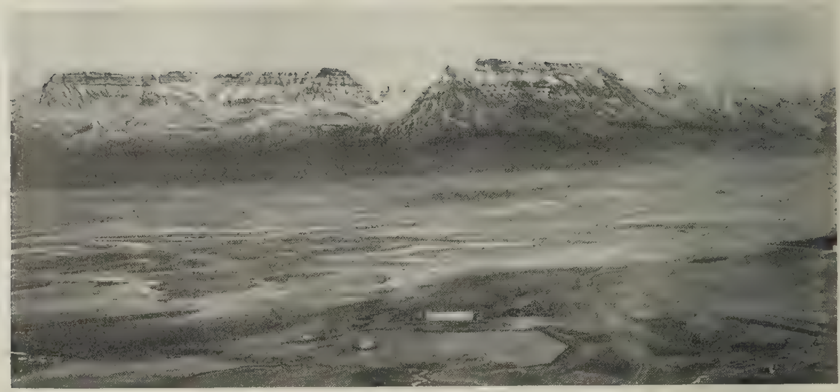

Fig. 8

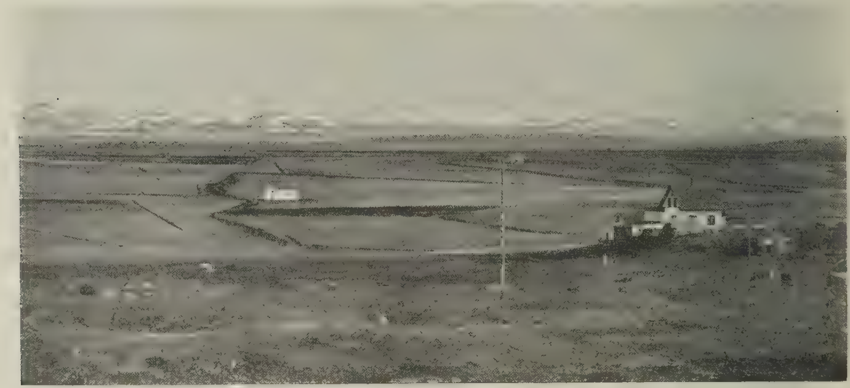

Fig. 9

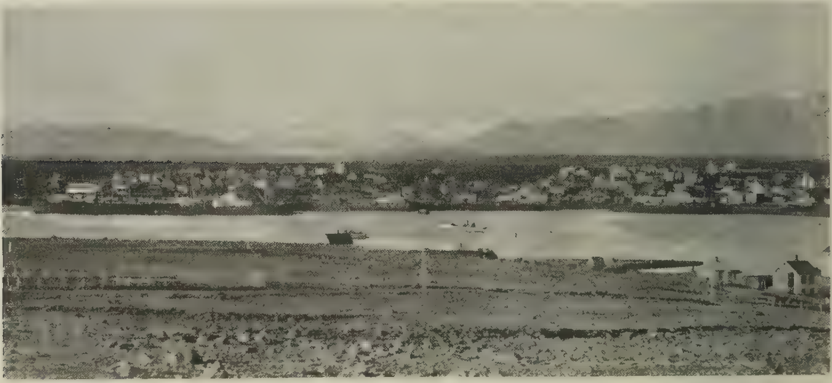

Fig. 10

Fig. 8—An Icelandic valley. View of Mt. Esja northeast of Reykjavík, from the south.
Fig. 9—The road to Hafnafjördr. View looking south from Reykjavík.
Fig. 10—The town of Hafnafjördr. Reykjavík lies beyond the first ridge.

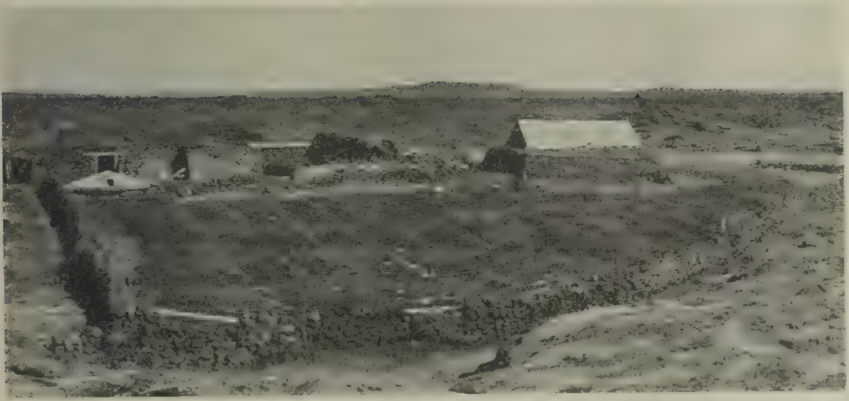

FIG. 11

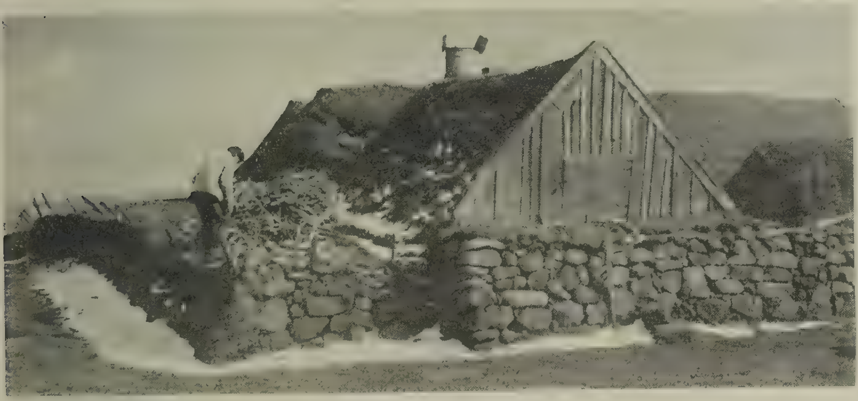

FIG. 12

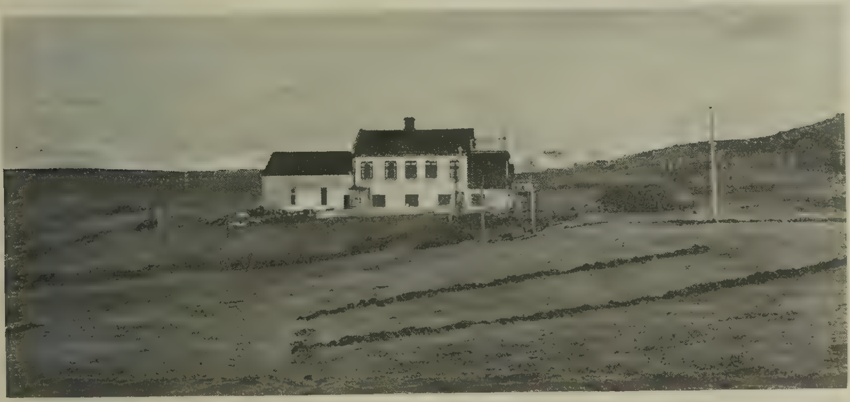

FIG. 13

FIG. 11—Old style farm sheds and buildings.
FIG. 12—Old type farmhouse near Sandgerdi, on the southwestern extremity of Iceland.
FIG. 13—Modern farmhouse near Reykjavík.

A number of horses are exported every year under the careful supervision of a government inspector. During the latter part of the nineteenth century most of them went to England for use in the coal mines. But now, because of the modernization of the mines, the market is shifting to Denmark. It is interesting that Denmark, famous for its own horses, should import Icelandic stock. But the ponies of the latter country are far cheaper both as to first cost and as to upkeep and are extensively used by small Danish holders as draft animals.

But by far the greatest item in the agricultural exports is mutton and sheep products—wool and green-salted sheepskins. The export of mutton, mainly salted, has more than doubled since 1900. Norway is the greatest market for this commodity. But last year the *Bruárfoss* was finished, the latest addition to the fleet of the Icelandic Steamship Company, carrying a complete refrigerating plant which will permit the shipment of frozen meat. This should tend to shift the market. England has large need of fresh foodstuffs.

The breeding of animals for the improvement of stock is one of Iceland's future problems. A beginning was made some years ago, when a few foreign sheep were imported for breeding purposes. Unfortunately they brought some disease with them which raised havoc with the native stock, causing the experiment to be abandoned. As far as the vegetable products of agriculture are concerned, there is a tremendous amount of work to be done.

One peculiar problem is that of the hummocks, which are found on almost every farm in the country and make the use of harvesting machinery, mowers, rakes, etc., virtually impossible. These hummocks have been described in detail by Thoroddsen.[12] They represent one phase of a phenomenon occurring in subarctic and arctic regions and due primarily to the alternation of freezing and thawing in a cold climate.[13] There is some agitation in Iceland for a fund to be used for study of the problem. Farmers spend years in leveling their fields, only to have the hummocks spring up again a few seasons later. They can be leveled by machinery, but this requires heavy plows and tractors.

Another problem to which the government is turning its attention is that of reclaiming land. Originally the Icelandic hills were supposed to have been covered with "forests," principally of scrub birch three or four feet high such as are still found in certain spots. These are said to have been destroyed by the sheep, which were allowed to roam all winter and gnawed the bark off the trees when the ground was covered with snow.[14] When the trees died, the soil was washed away or covered with sand. Today thousands of *krónur* are being spent, both for reforestation and reclamation of land through irrigation.

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[12] Thorvaldur Thoroddsen: The Botany of Iceland, Part I, 2: An Account of the Physical Geography of Iceland with Special Reference to the Plant Life, Copenhagen and London, 1914, pp. 261–264.

[13] Leonard Hawkes: Frost Action in Superficial Deposits, Iceland, *Geol. Mag.*, Vol. 61, 1924, pp. 509–513. Note the excellent illustration on Pl. 27, facing p. 513. See also J. S. Huxley and N. E. Odell: Notes on Surface Markings in Spitsbergen, *Geogr. Journ.*, Vol. 63, 1924, pp. 207–229.

[14] A view held by many Icelanders and expressed to me by Mr. Sigurdr Sigurdsson, one of the leading agriculturists of the country.

One extremely interesting phase of Icelandic agriculture in which beginnings have recently been made is irrigation for warmth, using the numberless hot springs. The average potato crop alone can be doubled in this way, both because of the artificial lengthening of the season and also because of the protection given against summer frosts. And by combining the use of warm springs with hothouses almost any of the common kinds of vegetables can be raised. One farmer near Reykjavík is making a fortune by sending his hothouse products to that city, which has to get nearly all of its fresh vegetables from the European mainland. A friend who spent last summer in Iceland,

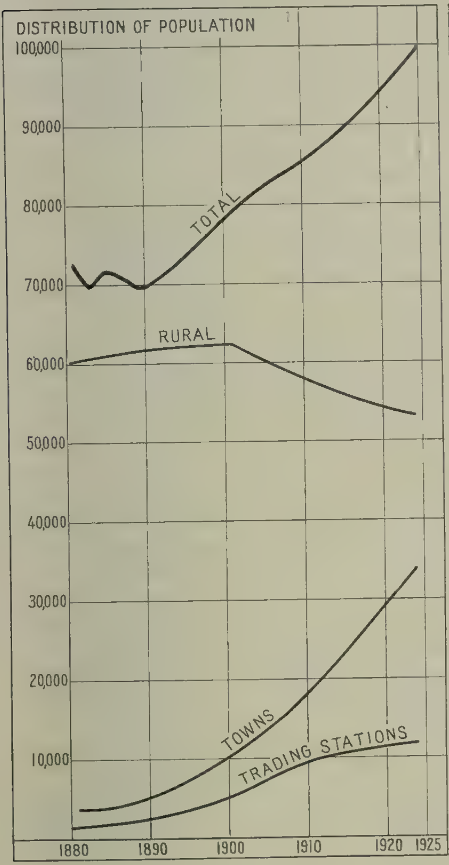

FIG. 14

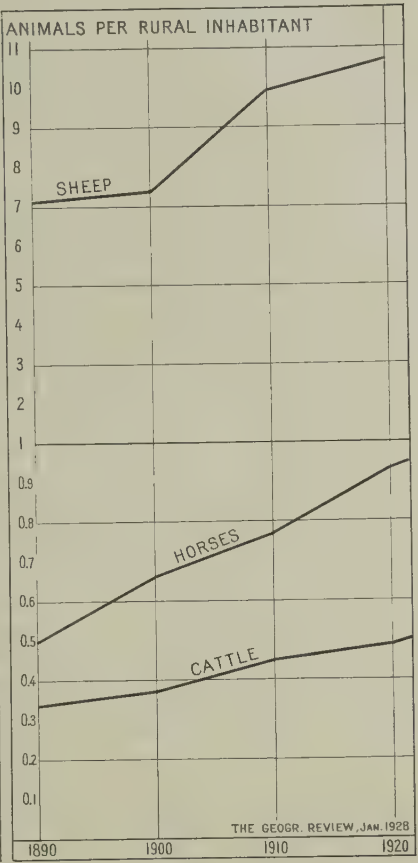

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FIG. 15

FIG. 14—Graph showing the recent growth of the Icelandic population distinction being made between urban and rural.

FIG. 15—Graph showing the per capita increase of live stock on Icelandic farms. Compare the curve for rural population in Figure 14. Figures from government statistics.

tells me that he saw spinach, cauliflower, and cabbage grown on the north coast, without the use of hothouses or warm springs. His visit was fortunately timed as the farmers did not know what to do with the spinach and had to be shown how to cook it.[15]

Progress in agriculture, however, has barely begun. Even today over two million kilos of potatoes and some 400,000 kilos of milk and dairy products are being imported annually. These figures should be cut enormously with the establishment of better distribution facilities and the improvement of agricultural methods. Artificial fertilizers, for instance, were not introduced until 1921. Today some 500 tons a year of nitrates and phosphates are being imported.

COMMERCE

In 1900 Iceland had an average annual export of about $20.00 per inhabitant. Today the figure is more than six times that amount, among the largest in the world. The import trade is slightly less. Thirty years ago two steamers, of about three-hundred tons capacity, made regular runs between the mainland and Iceland. Today there are nine, ranging in size from 800 to 1500 tons, and the number of tramp freighters has increased in proportion.

The exports, to which reference has already been made, are fairly simple in character. They consist of fish and fish products, farm products, mutton, wool, hides, live sheep, live horses, and a small amount of dairy products. The imports consist of practically everything used by a civilized people. And the commerce has only begun to grow. Given normal conditions it should again be tripled in the next two decades. The farmers are rapidly improving their standard of living as their isolation is broken down. For centuries Icelandic farmers were content to use dried sheep manure as their only fuel. Coal and even peat had to be transported on ponyback and hence were expensive. The annual or semiannual caravans to town had enough to do to carry necessities and liquor. But along the motor roads coal is becoming indispensable. It is the same with furniture, with clothing, with building materials, and with radio tubes.

The principal nations for trade are Denmark, Great Britain, and Spain. The latter, a Catholic country with a ready market for fish, is by far the greatest single buyer of Icelandic exports. Denmark has up to now been the leading seller of imports, mainly through force of a habit developed for centuries. But in 1924, for the first time in history, Great Britain had the lion's share of the nation's trade. This is only logical. Trade with Denmark means to a large extent trade through Danish agents. Denmark is an agricultural country and has little use for Icelandic exports. England is crying for foodstuffs and produces a great many of the things Iceland must buy—coal, machinery, clothing, etc. Indeed, the future prosperity of Iceland is completely tied up with the British Isles. It is there the country's dairy products are sold; it is there that wool is sold; and fresh meat and fresh fish will be sent also when a fleet of refrigerator steamers gets into service.

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[15] See also J. W. Harshberger: The Gardens of the Faeroes, Iceland, and Greenland, *Geogr. Rev.*, Vol. 14, 1924, pp. 404–415.

Not only for commercial purposes do the Icelanders look to England, but for protection as well. No treaty has ever been drawn up between the powers guaranteeing Icelandic neutrality, but as long as Great Britain remains the mistress of the sea Iceland feels secure. The little island country has a fine strategic position in the North Atlantic, and it is to England's interest to see that no foreign power gets a foothold there. More than a hundred years ago, when the Danish adventurer, Jørgen Jørgensen, declared himself king of Iceland and proclaimed the country's independence from Denmark, it was a British and not a Danish man-of-war which put in at Reykjavík and carried him off under arrest on a technical charge.[16]

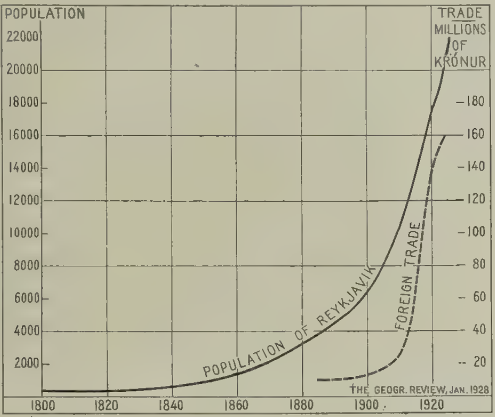

Fig. 16—Graph showing the growth of Reykjavík since the beginning of the nineteenth century and the recent development of Icelandic foreign trade. Figures from government statistics.

Prospects of Manufacturing Industry

The small variety in Iceland's exports places the country in a precarious position. Its prosperity varies with the price that Spain pays for fish. Let the price of fish go down and all the business men complain of hard times. Indeed, they claim that their country is a Spanish dependency. The prohibition law in Iceland was revoked at the command of the Spanish merchants. Only by allowing wines with up to 21 per cent alcohol into the country could an agreement be made with the Spanish government lifting a tariff on fish which would have been ruinous to Iceland.

The Icelanders are turning their hopes to manufacturing industry. At first glance it looks absurd that this handful of people with no raw materials of their own should become a manufacturing people. It is not so. Iceland has almost unlimited water power. The river Thjorsá alone can be developed to the extent of a million horse power. Between three and four times that amount are available in the other rivers. Where power is cheap, raw materials can be imported.

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[16] Gjerset, *op. cit.*, p. 354. Also a contemporary account is given by Sir George Stewart Mackenzie in "Travels in the Island of Iceland . . . ," 2nd edit., Edinburgh, 1812.

In Iceland, however, while a great deal can be done toward converting the country's present products, weaving wool textiles, canning fish, etc., the immediate industrial prospects fall into a different class. Any large-scale industry must be of a nature requiring little man power. The Icelanders are too few in number to support large woolen mills and too careful to protect their national life to permit the importation of large bodies of foreign workmen. This narrows the industrial possibilities down to electro-chemical conversion, either of nitrates or aluminum. Neither requires extensive man power, and both are more dependent on cheap electric power than on the price of raw materials. Nitrates can be made out of thin air; aluminum deposits of commercial value are found in Iceland, otherwise so poor in mineral resources.[17]

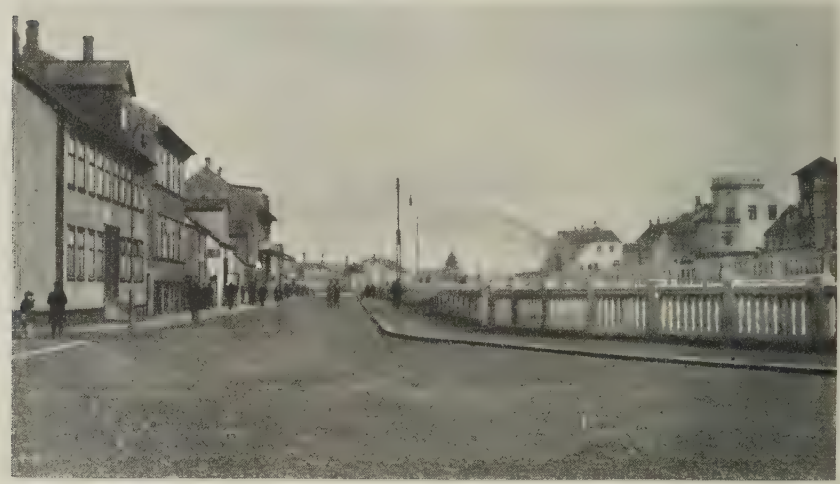

FIG. 17—Street in modern Reykjavík.

Icelandic industry is as yet only in the speculative stages. When the country does become an industrial nation it will have unique and interesting technical problems to offer. No spot in the world gives the engineer a better opportunity to experiment with the utilization of volcanic heat. The Icelanders are watching with tremendous interest Italy's natural steam power plant at Lardarello, Tuscany. They themselves are making a good beginning in the use of the hot springs. Several farms are heated with natural hot water. A small woolen mill near Reykjavík pipes a hot spring into the building and uses it entirely for heating and drying. A large national hospital and two schools now under construction in Reykjavík will be heated entirely by this means. Iceland's coal bill could be cut enormously through more complete utilization of the hot water which is on hand in unlimited quantities. The possibility of heating the whole city of Reykjavík with water from the hot springs at Hengill, some fifty kilometers away, has been discussed.[18] The scheme is visionary as far as practical application is concerned; Reykjavík will have to be half again as large as it is before it is economically feasible. But the idea is there.

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[17] A large bauxite deposit was found in the northwestern part of the country last year. On sending a sample of it to England, the owner immediately received an order for 500 tons.

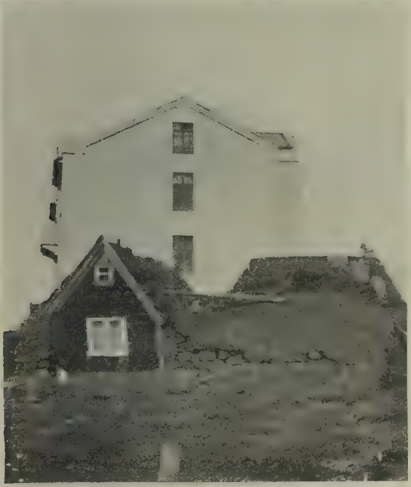

FIG. 18

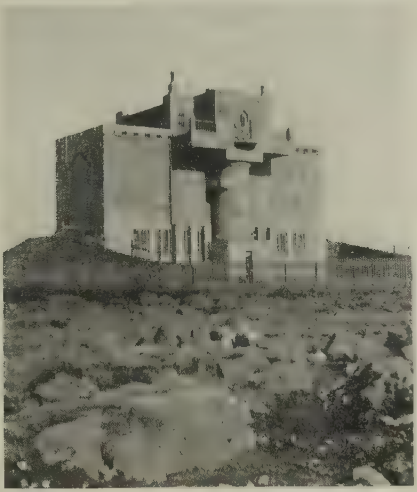

FIG. 19

FIG. 18—Reykjavík's evolution in building. The oldest house in the city, contrasted with one of the newest.

FIG. 19—Einar Jonsson's museum of modern Icelandic sculpture.

TOURIST INDUSTRY

The tourist industry offers tremendous and immediate possibilities for the country. Tourists today are ever on the lookout for the unusual. There is little doubt that in a short time, when adequate facilities for their reception and housing are on hand and when Icelanders have learned more about the arts of propaganda and advertising, the country will be overrun by travelers, attracted no less by the impressive scenery and the fine clear air than by the romantic name. Even today almost every boat from England during the summer season is crowded with British visitors, drawn in part by curiosity and in part by the sporting lure of the rich trout and salmon rivers. As a health resort, too, rivaling and surpassing the most famous of European baths, Iceland has great possibilities through its numberless hot sulphur springs.

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[18] Jón Þorláksson: Hitaveita Reykjavíkur, *Tímarit verkfraedingafjelags Islands*, Vol. 11, 1926, pp. 41–44.

POPULATION AND MOVEMENT

Iceland is by far the most sparsely populated country of Europe. With a population of 100,000 and an area of 40,000 square miles, it has a population density of about 2.5 per square mile. In this figure, however, a sharp differentiation must be made between the average and the effective density. About 31,000 square miles of the interior are uninhabited and for the most part uninhabitable, because of glaciers, lava fields, and barren sands. This leaves 9000 square miles for 100,000 inhabitants, or an effective density of 11.1, about the same as that of North Dakota and Nebraska today and of North Carolina in 1810. The small population constitutes a formidable problem in Iceland's economic development. For a great many years, up to the time of reaching the saturation point, the country's productiveness can be increased at a much faster rate than the population. Internal transportation, railroads, and highways pay returns, direct and indirect, in almost direct proportion to the density of population served.

TABLE II—DISTRIBUTION OF POPULATION ACCORDING TO OCCUPATION

OCCUPATION	NUMBERS		PER CENT	
	1880	1920	1880	1920
Farming	53,000	43,800	73.2	46.2
Fisheries	8,700	18,700	12.0	19.8
Handicraft and industry	1,500	11,200	2.1	11.8
Commerce and communication	2,600	12,700	3.6	13.4
Total	65,800	86,400	90.9	91.2

But if Iceland is underpopulated, immigrants are by no means welcome. The country's population is increasing at the rate of 1.14 per cent a year. In 70 years it will be doubled. The Icelanders feel that their country must be held open and made ready for its future inhabitants. In the forward steps they are taking they are concerned with their own well-being and with that of their descendants, not with the glory of the nation. In the parliamentary debates concerning water-power concession and industrial development one can see the fear of large bodies of foreign workmen coming into the country to the danger of Iceland's national life. The Norwegian Titans Company received permission to import a limited number of laborers for the purpose of building the railroad on the express stipulation that they be taken out again when the work is done.

We witness in Iceland the amazing growth of the cities, especially of Reykjavík (Fig. 16). The Icelandic cities have come home. A hundred years ago they were on the European mainland—Copenhagen and other Danish cities and, to a certain extent, Hamburg and London were performing the city functions of the nation. Reykjavík a hundred years ago was a trading post of three hundred inhabitants. Today, with its 22,000 inhabitants, it contains about one-fourth of the population of the whole country. Iceland, too, has its movement away from the farms. The cities with their higher wages and their more comfortable life, their motion pictures and cafés, are drawing the population in increasing numbers. Figures 2 and 14 show graphically the movement of population. Table II gives a picture of the "occupational" movement.[19]

The increase among those engaged in commerce and communication is probably the most significant as far as the national life of the nation is concerned. It not only signifies the readjustment in the whole economic structure but demonstrates the creation of and the movement to the "white-collar" class of jobs as well.

If the Icelanders are intelligently bent on their country's progress they are also intelligently aware of the evils thereof. For these, apparently, there is no cure at present. Periodic labor discontent comes with specialization of occupations. Class divisions and class struggles arise when a nation becomes organized for efficiency. All of these have faintly begun to show themselves.

The cultural life of the nation also is undergoing a profound change. A revival in art, sculpture, painting, literature has sprung up, to be sure;[20] but the cultural life of the masses is deteriorating. In the country the necessity for reading, which brought about such a widespread knowledge of Iceland's classics and history, is disappearing as the farms lose their isolation. The radio, the telephone, the automobile, the motion pictures in the cities, and trading posts are doing away with the long evenings of fifty years ago, when the housefather gathered his family and servants around him and read aloud from the sagas. Soon it will be impossible to see a child of twelve or thirteen studying botany from a Latin treatise for recreation.[21] Education for a purpose produces far different results than education for its own sake.

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[19] From "Iceland."

[20] Godmundur Kamban: Modern Iceland, *Geogr. Rev.*, Vol. 5, 1918, pp. 195–207.

[21] Russell, Iceland, p. 125.

SOME GEOGRAPHIC ASPECTS OF CUBAN SOILS*

Hugh Hammond Bennett

U. S. Bureau of Chemistry and Soils

[With separate map, Pl. II, facing p. 80]

PROBABLY in no other country of the world has soil character had stronger influence upon national welfare than in Cuba. The wealth of the island has been derived directly and almost wholly from its varied soils. The red lands were taken up first because of their good productivity and easy cultivation, and upon these many fortunes have been made and much good citizenry bred. But there are other favorable types, and if the land has produced largely in the past it is susceptible of great increase both in amount and range of products.

While agricultural operations coincident with the huge production of cane sugar and with the other crops has extended over a very large part of Cuba's better lands, there still remains some arable soil that has never been touched, chiefly in the eastern provinces, the Isle of Pines, and in parts of the western province of Pinar del Rio. The greater part of the cultivated land consists of clay, and large areas of this are of such heaviness that intensive treatment is essential for good yields. Many thousands of acres in cane represent stump land that has never known a plow. On the more easily tilled sandy lands of the west and the widely distributed savanas the chief problem of production is that of artificial fertilization, since these lands generally are of low natural productivity.

As it is, Cuba imports far too much of her food supply—in 1924 to the value of over $100,000,000. She should supply her own needs and expand her exports, considering her favorable climate and available soils. This article deals primarily with the latter asset. The kinds and distribution of soils are shown in generalized form in Figure 1, the first soil map of Cuba to be published.[1] Brief discussions of topographical relations and of some agricultural implications follow.

General Topographic Features

In traveling by rail from the western city of Pinar del Rio eastward through Rincon, Guines, Jovellanos, Santa Clara, Ciego de

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*This paper is based chiefly upon data collected by the author and R. V. Allison of the Tropical Plant Research Foundation in carrying out a reconnaissance survey of the soils and agriculture of Cuba, during 1925 and 1926, as a coöperative project between the Soils Bureau, U. S. Department of Agriculture, and the Tropical Plant Research Foundation.

[1] A more detailed soil map of Cuba by the author and R. V. Allison will accompany a report in course of publication by the Tropical Plant Research Foundation.

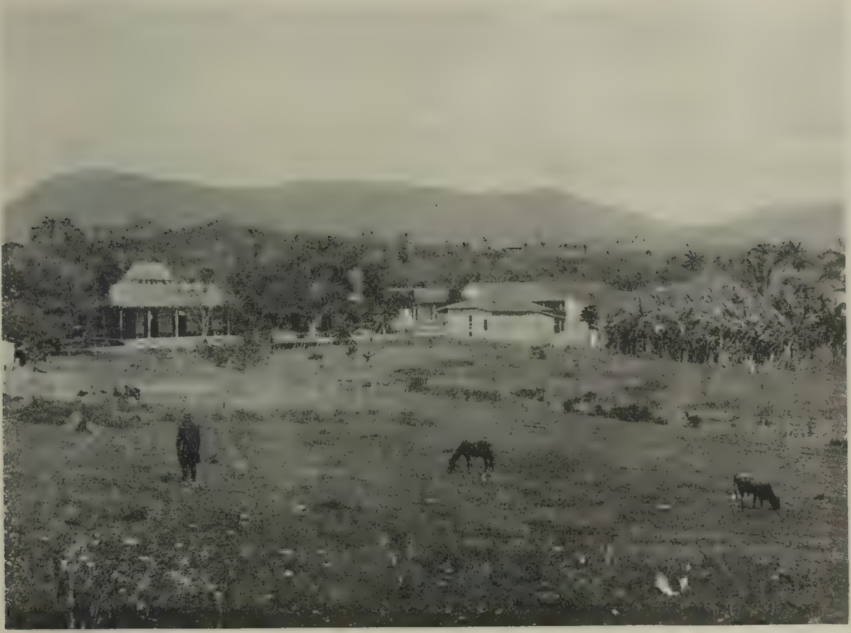

FIG. 1

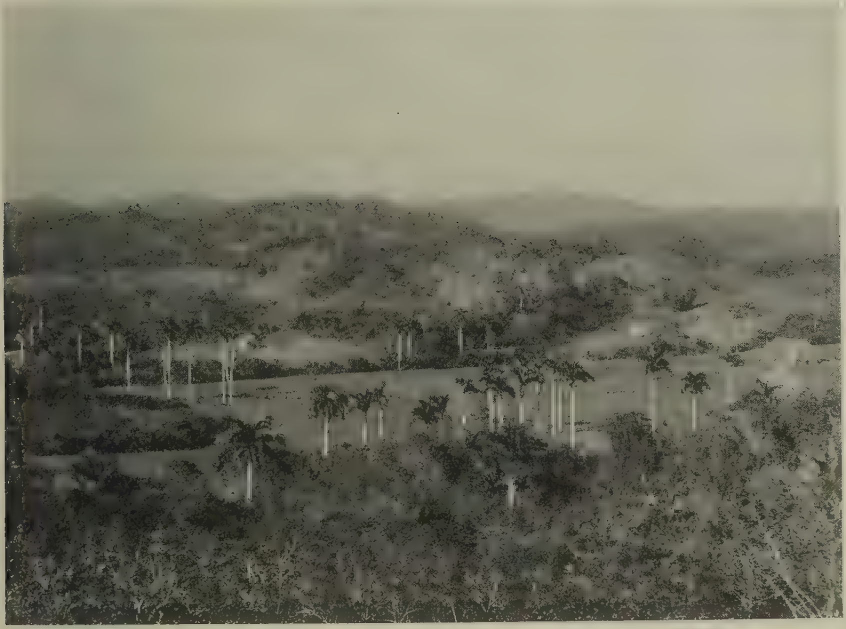

FIG. 2

FIG. 1—A typical rural scene along the base of the Organ Mountains near San Diego de los Baños.

FIG. 2—An intensively cultivated stream valley in the central part of the Province of Pinar del Rio. The crop is tobacco.

Avila, Camagüey, and Victoria de las Tunas to Alto Cedro in the province of Oriente, very little but flat and gently rolling country is crossed. There are a few hills, such as those in south-central Habana Province, and some rolling areas, as those between the city of Santa Clara and the Jatibónico River and in the eastern part of Camagüey. About 300 miles of this journey is over flat or nearly flat country. In the central part of the Province of Matanzas the surface is flat from the north coast of the island to the south coast, with probably no point much higher than 100 feet. Again, the whole transverse section of the island from a line some miles west of Ciego de Avila eastward nearly to the city of Camagüey is very largely flat, although varying locally to gently rolling, with an occasional isolated hill or small group of hills.

Aside from the great mountain massifs of eastern Cuba, areas of strong relief are restricted principally to the highlands of Pinar del Rio, the Trinidad Mountains, the Holguin Hills, and the broken line of hills extending along the north coast. Except for the hills and mountains in Santa Clara, the southern two-thirds of this major part of the island consists very largely of flat country. On the eastern side of the extensive flat belt reaching from Manzanillo near the Cauto River across the Alto Cedro Plain to Nipe Bay on the Atlantic, approximately 80 per cent of the country is mountainous and hilly, with many peaks rising to 3000 feet and one to 8000.

Altogether about three-fifths of the island is flat to gently rolling and admirably adapted, so far as topography is concerned, to the use of any kind of farm machinery. Some rather extensive belts consist of marshland, such as that found in the peat bogs of Zapata, where it is difficult even to walk on the soft, water-soaked material. Also, considerable areas of flat, heavy clay land become so hard on drying that powerful tractors or cable plows are necessary to effect satisfactory deep tillage; while still other tracts comprise rocky land with very little soil. Additional extensive flattish and undulating areas consist of thin savana land and lean, shallow soil having little value except for the pasturage afforded.

The remaining two-fifths of the country consists of strongly rolling hilly and mountainous land, of which probably one-half is arable although some of the cultivable portion consists of steep slopes where continuous cultivation eventually would be followed by wasteful erosion.

In summing up it may be said that the minimum area topographically and otherwise suitable for cropping appears to be in the neighborhood of 52 per cent of the island, or nearly 23,000 square miles. Not all of this consists of high-grade farm lands, although the greater part is good soil or can be made good soil by proper treatment. A further extension of the area of farm land may be found possible through the utilization of some of the well-drained areas of thin soil and stony land for the production of henequen (sisal).

The areas of rougher surface do not, however, represent waste land only; some is forested, other tracts can be brought into forest, while a considerable part has value for grazing.

Many of the smaller streams flowing toward the sea never reach it but become clogged of channel in the broad coastal lowlands, spreading over the expansive flats to add to the accumulation of water from rain falling directly on the surface. Thus large tracts of coastal plain are inundated for long periods during the rainy season, causing damage to crops and preventing timely cultivation. Much coastal plain land of this kind has been left in forest or is used only for pasturing stock.

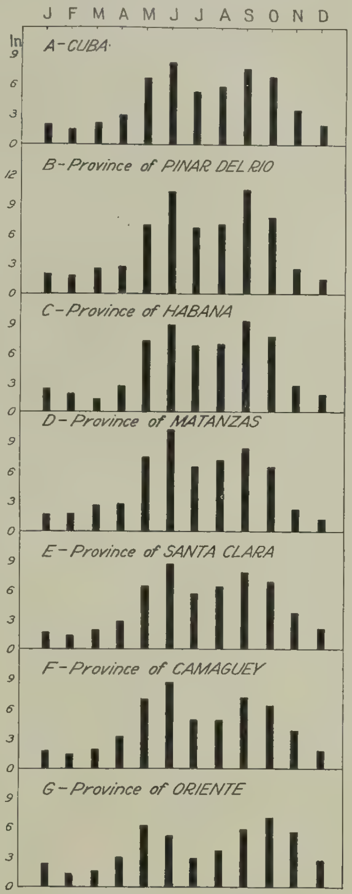

FIG. 3—Average monthly rainfall of Cuba (1899–1924), reproduced from O. L. Fassig: Rainfall and Temperature of Cuba, *Tropical Plant Research Foundation Bull. No. 1*, 1925. "In all provinces there is a minimum rainfall in January or February with a steady increase to a maximum in May or June, followed by a decrease in July, with a secondary maximum in September or October."

In the red lands dominating the plains of Camagüey and of Ciego de Avila, streams are of very infrequent occurrence and are generally without water in the dry season except where they have their sources on the higher-lying watersheds. One area of 500 square miles in southeastern Matanzas Province has not a single streamway throughout its entire extent. The red soil, although composed largely of clay, is so porous that practically all of the rain falling on it passes rapidly downward into the ground with little or no run-off. There are openings, or sink holes, here and there, through which some water sinks into the basal limestone; but most of the rainfall, amounting to approximately 70 inches, passes directly into and through the soil, which has the high pore space so characteristic of well weathered tropical clays. Part of this water travels by underground streams, known as *sumideros*, into the sea where it is forced up through salt water to form the fresh-water "boils" or ocean "springs" at short distances offshore. Sometimes after continuous heavy rains, underground water, flowing in reverse direction under pressure from

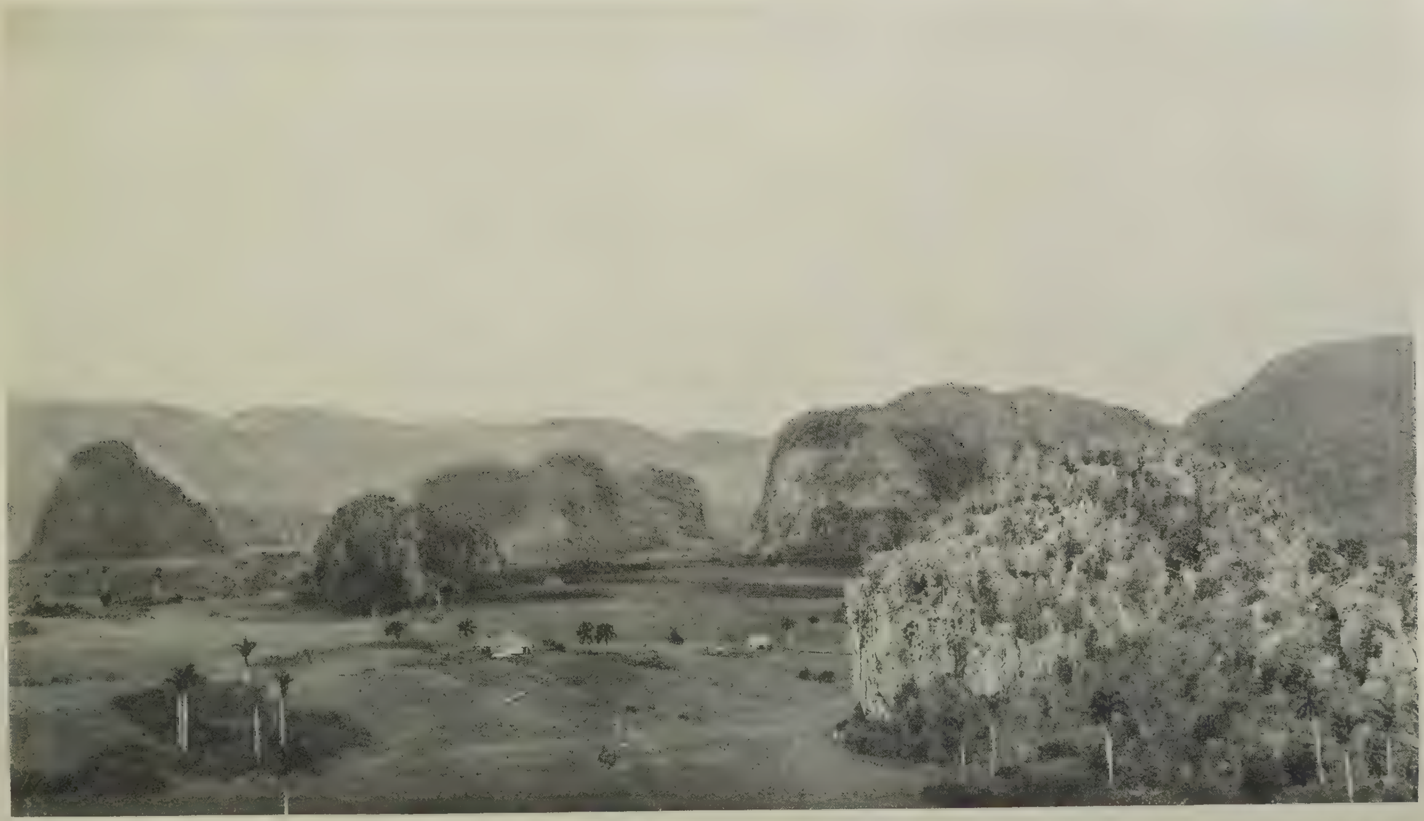

FIG. 4—Blocklike monoliths of cave-riddled limestone (*magotes*), Viñales Valley section of the Guaniguanicos, western Cuba. Some of these strange masses of limestone rise to more than a thousand feet from the floor of the valley.

higher areas, boils up through the ground by way of these subterranean passages. In Camagüey Province during the heavy rains of the summer of 1926, water boils of this nature are reported to have broken through the dirt floors of some of the native houses.

Drainage of these low wet lands is one of the major problems confronting the improvement of many thousands of acres now being used for sugar cane, with none too good results. A few canals already have been dug on several plantations, but practically nothing has been done in the way of establishing large and properly coördinated drainage districts.

Some Special Features: The Guaniguanicos

The Guaniguanico Mountains, comprising the western part of the highlands of Pinar del Rio, are worthy of special mention because of their unusual topographic features. They rise from a smoothly undulating plain in the form of huge blocks and mesas, known as *magotes*, to a maximum height of about a thousand or twelve hundred feet above the supporting floor. The plain lies considerably below the enclosing strips of piedmont hills, having attained this position through the more rapid dissolution and removal of the basal limestone than has taken place in the resistant schists and other crystallines of the hill country to the north and south. From these higher piedmont positions one looks down upon a beautiful valley, a prodigious sunken garden. The limestone monoliths rising abruptly from the valley floor, with almost perpendicular walls, have a remarkable likeness to artificial structures. In places deep defiles separate the *magotes*, giving the appearance of a city of castles. At close range the great monoliths are seen to be riddled with caverns and lesser openings.

Stalactites descend from overhanging ledges and from the roofs of caves; the face of the cliffs is vertically streaked with white lime precipitate from dripping waters. Ceibas, with their green trunks, grow fantastically on shelving positions and in cracks where there are small accumulations of disintegrated rock and soil, and royal palms form a narrow fringe of forest along the immediate base of the cliffs. The mountain sides and tops, however, largely consist of bare rock.

The *magotes* undoubtedly owe their block-like form to the tumbling in of the roofs of caverns and the spans of natural bridges. Natural bridges were observed in several parts of the system, as well as the remnants of bridges which had caved in. In time the remaining masses of these picturesque highlands will succumb to the undermining that already has honeycombed them to their very heart, and finally there will be left a normal limestone valley lying between ridges of schist rocks that once were the foothills of the limestone range now disappearing. But this is not going to take place immediately, and in the meantime here is to be seen a unique orographic feature of the western hemisphere; indeed, there probably are not many places in the world where this type of mountain exists. In the southern part of the Malay Peninsula there is a similar chain of monolithic limestone highlands.[2]

It seems strange that so magnificent a spectacle as the *magotes* of the natural sunken garden called Viñales Valley are seldom visited by Americans living almost within a stone's throw. Apparently few outsiders have even heard of the region or of the many other charming features of western Cuba: its delightful valleys, the grotesque bottle palms, the clean bright towns and cities, where nearly every house has its frontal row of Grecian columns, the pleasant sunshine of winter, and a landscape dotted with colorful tobacco farms.

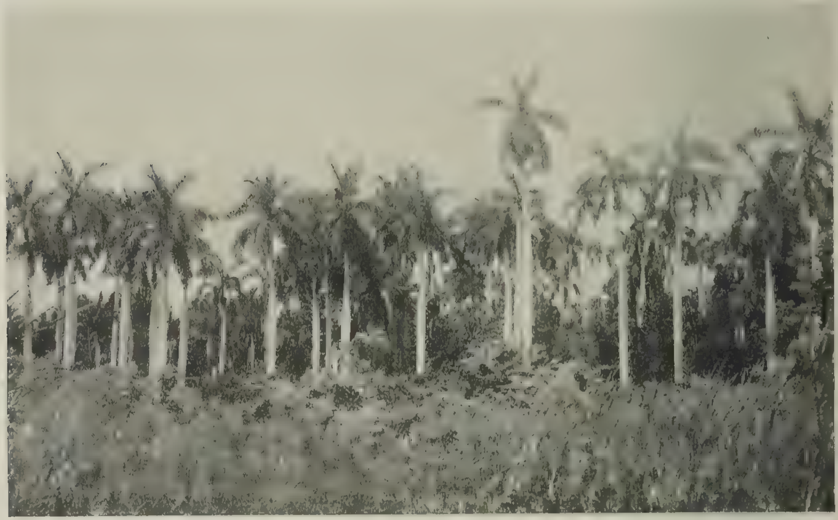

FIG. 5—A swamp of royal palm and dense undergrowth of water-loving plants in the western projection of Zapata Swamp.

ISLE OF PINES

The northern part of the Isle of Pines consists of a peneplain developed on schist rocks of a highly quartzose character, some ranging to pure quartz schist. The surface is flat to gently rolling, with some hills in which the country rock has been but slightly altered. Some of the lower flats along the coast and the streams have been formed of material washed out of the higher areas of schist-derived soils. These correspond closely to the more poorly drained types of the flatwoods areas of the southeastern United States. Predominantly, however, the soils of the higher positions are sandy loams with a high content of quartz and schist fragments. Light-colored sandy soils, with cover of pine, palmetto, and wire grass, they resemble the sandy lands of Florida and are responsible for the statements sometimes heard to the effect that the Isle of Pines is a bit of Florida transplanted to the Caribbean. The comparison is sound only in the superficial resemblance; for the soils, the dominant types, are markedly unlike those of Florida in their origin and actual characteristics, and the vegetation includes a considerable number of plants not found in Florida, such as the bottle palm and several tropical hardwoods. On the other hand, in being well drained and sandy the crop adaptations correspond to those of better-drained sandy lands of the Florida Peninsula, and their low natural fertility, as in Florida, calls for liberal fertilizer treatment.

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[2] J. B. Scrivenor: The Physical Geography of the Southern Part of the Malay Peninsula, *Geogr. Rev.*, Vol. 11, 1921, pp. 351–371.

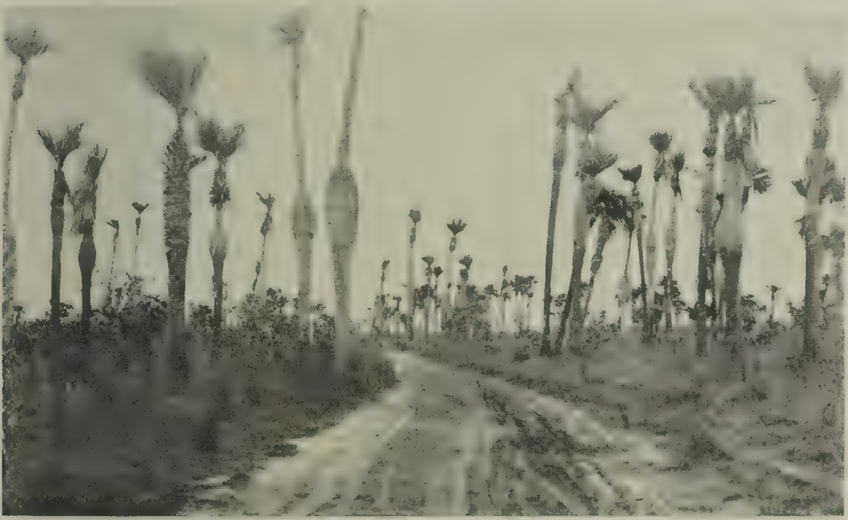

FIG. 6—Bottle palms on sandy soil of the Caribbean coastal plain, Pinar del Rio. Leaves partly stripped off for roofing tobacco-curing barns.

These sandy lands of the Isle of Pines correspond in origin to much of the soil found in the piedmont areas of western Cuba. They are usually deeper, however, and much better suited to agricultural utilization, such as the growing of vegetables and grapefruit.

Rising above the sandy peneplain constituting the northern part of the island are a number of high limestone peaks. These stand above the smooth plains in striking conspicuousness. The southern part of the island, that lying south of Lanier Swamp, is mostly shallow limestone soil and bare *piedra hueca*, holey rock, so called from its cavernous nature.

COASTAL PLAIN OF WESTERN CUBA

The coastal plain strips of western Cuba, the areas lying to the west of the red lands belt, are markedly unlike the coastal plain areas in other parts of the country in that the soils are very largely sandy; whereas in central and eastern Cuba the low coastal lands are principally occupied by heavy clays.

These western sandy lands, formed of material washed out of the piedmont areas, correspond for the most part with the soils of the coastal plain regions of the southeastern United States. Most of the types have their duplicate in the latter country, although several have never been identified therein. Much of the soil used in growing the finest cigar leaf produced in the Vuelta Abajo tobacco district consists of the Greenville, Orangeburg, and Ruston fine sandy loams, all of which are of abundant occurrence in southeastern United States.

There is a considerable stretch of flatwoods country southwest of Guane that corresponds in every respect with much of the flatwoods of the Florida Peninsula, having precisely the same soils, the same vegetation of pine, palmetto, and wire grass, and even the shallow lakes and intermittent lakes so common to the latter region.

The Zapata Peninsula Region

This division, situated largely in the southwestern part of Santa Clara Province, consists principally of swamp land, together with some important areas of rocky limestone land, where there is little or no visible soil. The swamp consists of peat bog and soft, whitish marl, both covered with water or saturated throughout the year. Both types of swamp support two principal kinds of vegetation: timber and open glades of saw grass. The latter predominates, but there are important forests of mixed hardwoods along the inner border, and there are fringes of mangrove near the sea and along waterways. In many places the peat is more than five feet deep and is entirely too boggy for use as pasture land. The marl also is deep, soft, and mirey. The Zapata Swamp essentially duplicates the characteristics of the Florida Everglades.

Cost of drainage will militate against reclamation in this region, at least until the less swampy higher-lying areas have been used.

The stony areas are honeycombed with cavities in which there is soil for plants that have their beginning in shallow surface accumulations of soil, disintegrated rock, or leaves. Roots straying out from these find their way through the holes and into sufficient soil to support, in some places, a fair type of forest.

The Nipe Mountains

The Nipe Mountains, ranging from about 2000 to 3000 feet in elevation, comprise the western extension of the great eastern mountain massif. They are of interest chiefly because of the deep beds of red soil or iron ore covering the smoother parts of the summit. In

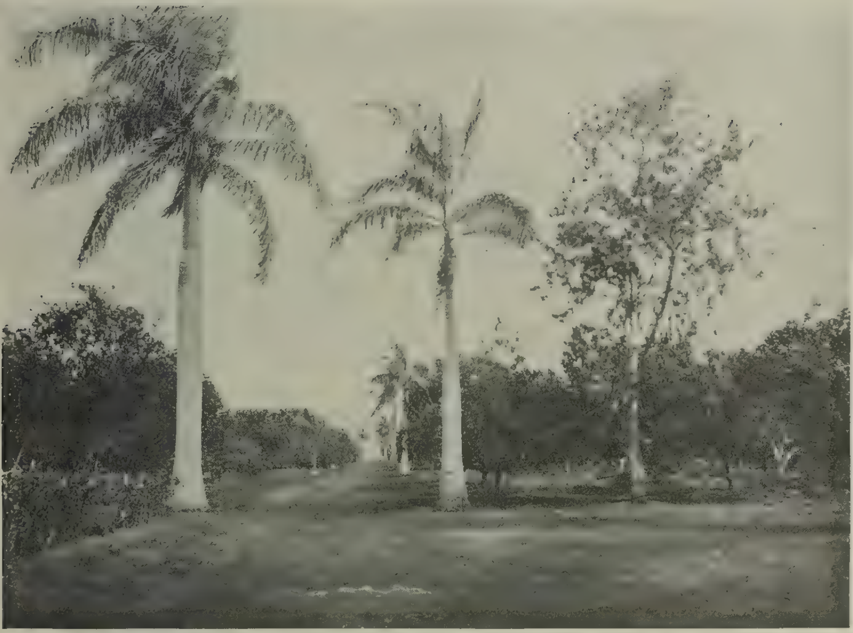

FIG. 7

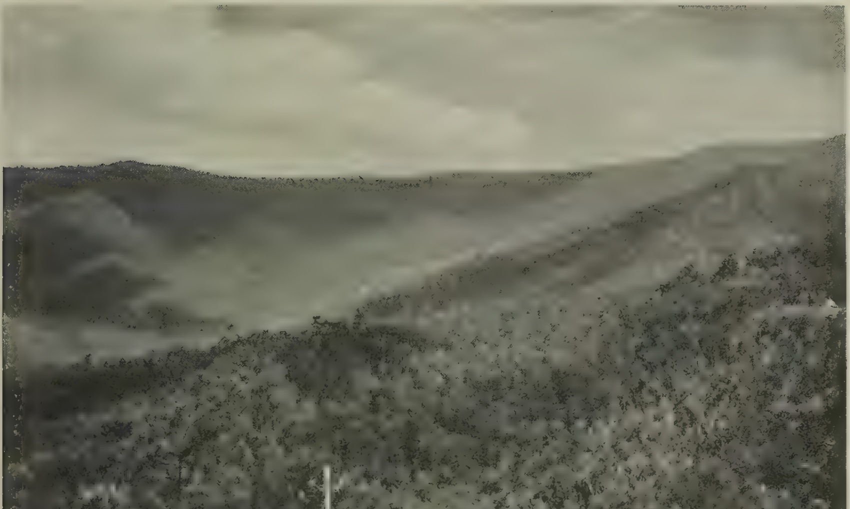

FIG. 8

FIG. 7—Orange grove on Matanzas clay at Ceballos, Province of Camagüey. Fruit of excellent quality is produced in this locality, both with and without irrigation.

FIG. 8—Pine lands and mixed hardwoods of Nipe Mountains. In the background an extensive burned-over area. Squatter farmers operate on small clearings of limestone slopes (see Fig. 9). (Photograph by Matthews and Crosby.)

places the rock from which the soil has been formed, mainly serpentine, has decomposed to depths of 50 feet or more; and so complete has been the weathering that the soil has lost nearly all its elements of plant food as well as most of its silica. Much of the material contains less than three per cent of silica, only traces of lime and phosphorus, and but little magnesia. On the other hand, iron is present in amounts up to 70 per cent or more, and alumina up to 18 per cent. In other words, this is severely weathered or laterite soil, too poor for crop production. It is so exceedingly porous that nearly all of the rain passes down through it as fast as it falls, and there is practically no erosion. Although of high clay content, the material is very friable. Pine forest and scattering coarse grass are present.

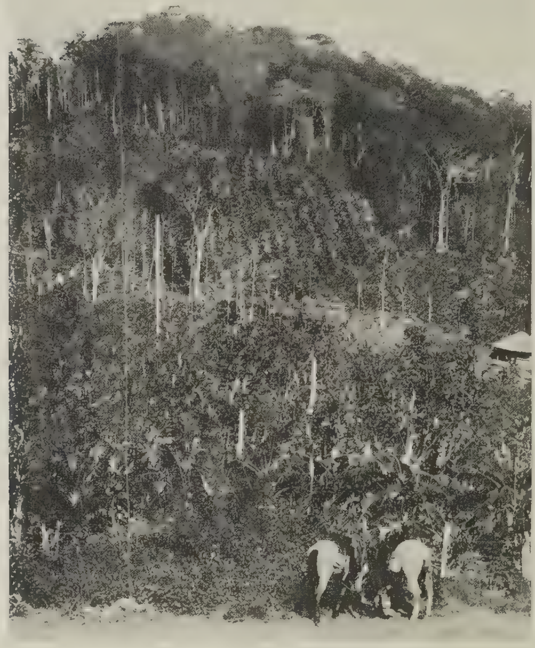

FIG. 9—Bananas and plantains on squatter clearing in Nipe Mountains. This very steep slope of thin limestone soil will suffer from erosion after a few years of cultivation. (Photograph by Matthews and Crosby.)

THE VEGETATIVE COVERING

Fairly heavy timber originally covered the lowlands of the island except the savanas and the excessively stony areas and peat bogs. The abundant mangrove swamps of the islands (keys) and the low clay lands immediately along the coast support small trees having but little present value, save for charcoal and tobacco poles. A few exceptionally dry localities of limited extent, such as that of the lower Guantánamo Valley, support only small trees, stunted palms, cacti, and semi-desert bush growth. There are pine-covered tracts in Pinar del Rio, on the Nipe Mountains of eastern Cuba, and over the greater part of the Isle of Pines. Fairly heavy timber is found over considerable stretches of the eastern mountains. On the other hand, great areas of mountain country are so stony that as a rule only small trees are found. A peculiar vegetative condition prevails on some of the areas of *piedra hueca*. On the large tract of this kind found

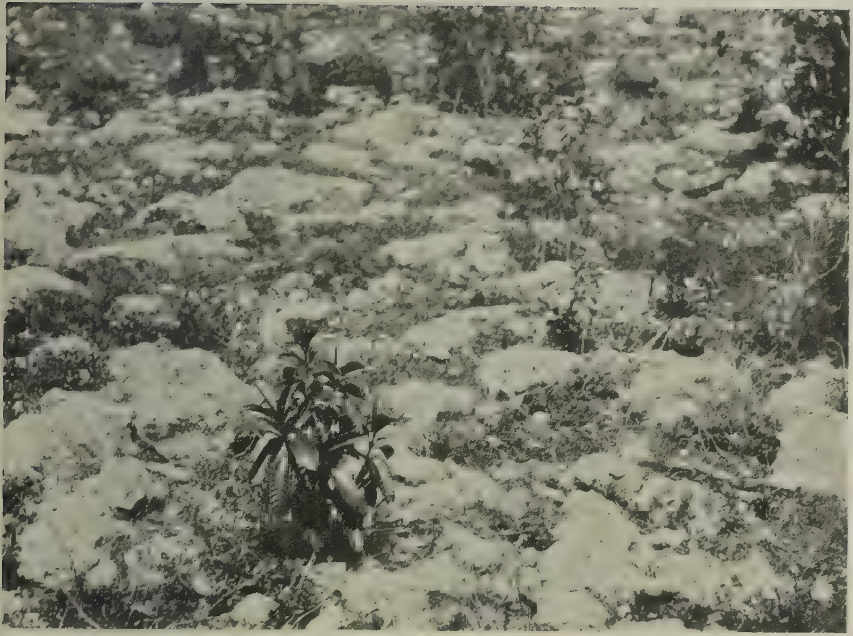

FIG. 10

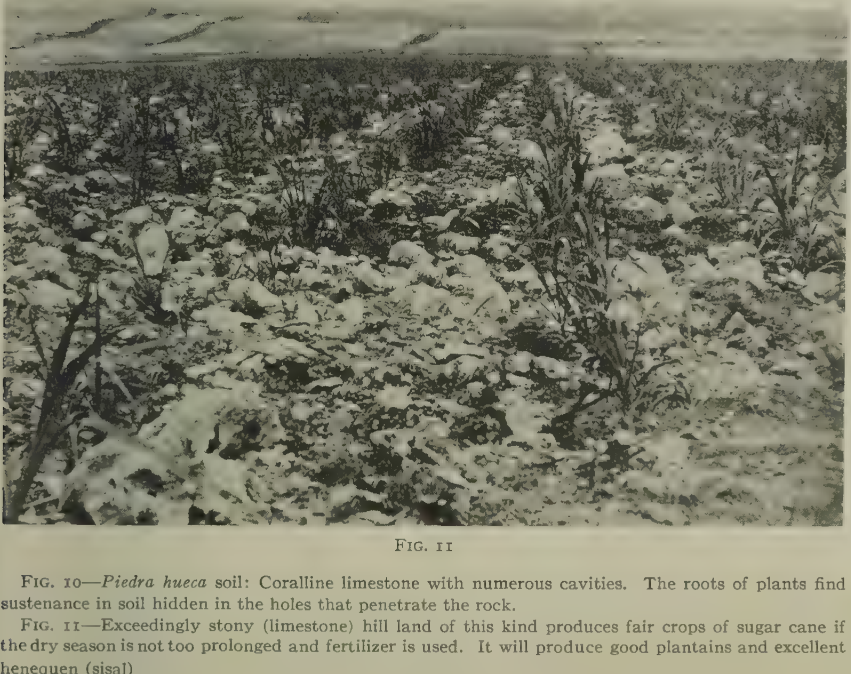

FIG. 11

FIG. 10—*Piedra hueca* soil: Coralline limestone with numerous cavities. The roots of plants find sustenance in soil hidden in the holes that penetrate the rock.

FIG. 11—Exceedingly stony (limestone) hill land of this kind produces fair crops of sugar cane if the dry season is not too prolonged and fertilizer is used. It will produce good plantains and excellent henequen (sisal)

on Zapata Peninsula, huge silk-cotton trees (ceibas) are to be seen in places where no soil whatever is visible, and there are many other species of trees of fair to good size. Here plants find sustenance in soil that is hidden in the deep holes that ramify the rock.

The native lowland forest varies considerably, according to drainage and soil. Certain species which are very abundant on the imperfectly drained black and brown clays of the *Bayamo* soil group are rare or altogether wanting on the perfectly drained red clay of the *Matanzas* type. Locally, royal palm is plentiful on both well drained and swampy clay soil and is one of the characteristic features of the landscape over most of the country; however, over some types of clay land it is entirely absent and on the savanas and the poorer sandy lands it is usually absent.

Hardwoods are found in large numbers through the heavier forests, and there are also numerous soft species. It is stated that some two hundred hardwoods are indigenous to Cuba. Most of these are put to some use by the natives. After seeing in Havana and some of the other cities excellent furniture and doors of finely carved mahogany, it is a shock to find that this beautiful cabinet wood has not only been used very extensively for crossties and ordinary construction purposes but has even been burned on a very large scale in the clearings made for sugar cane. Many plantations have done away with all or nearly all of their valuable forests in the madding haste to extend their cane plantings or bring up the yield by taking new land into cultivation. Relatively more of the timber has been saved recently, on account of scarcity of wood. In 1926, however, the writer heard of "good burns" on freshly cleared land and saw hundreds of acres of valuable wood go up in smoke.

There is immediate need on the part of the nation, as well as many large sugar centrals, of getting under way reforestation projects on abandoned areas and on certain good timber soils that are giving ridiculously low yields of cane. One or two plantations recently have developed plans for reforesting some of their lands.

The charcoal burners have been berated as destroyers of timber. This charge in most instances is unjustified, since these operators confine their activities chiefly to isolated swampy and rocky coastal areas, where there is but little really good merchantable timber. Furthermore, they do not annihilate the forests as the large agriculturists have done but leave many small trees for rejuvenation of closely cut-over tracts.

The savana areas, because of infertile sandy soil and shallow clay over rock, are largely covered with grasses, palmettos, bushes, and small trees. These areas generally are much better suited for live stock than for crops. Large and widely scattered tracts having no crop value whatever afford at least fair grazing.

CUBA AN AGRICULTURAL NATION

After a few days of travel through the provinces east of Pinar del Rio, one gains the impression that Cuba is a prodigious sugar-cane field, with some local interruptions represented by tobacco fields and patches of corn, plantains, beans, and vegetables. Tobacco is an important sale crop, but the area devoted to it is small compared with that of the cane fields.

The extent to which the island is agricultural in its activities is indicated by the value of exports presented in Table I.

TABLE I—VALUE OF CUBAN EXPORTS FOR 1924*

PRODUCT	VALUE	PER CENT OF TOTAL VALUE OF EXPORTS
Raw sugar, molasses, and other products of sugar cane	$384,643,000	88.4
Tobacco and tobacco products	39,406,000	9.1
Fruits and vegetables	5,202,000	1.2
Forest products and textile fibers	726,000	.2
Animal products, etc.	2,118,000	.5
Mineral products, sponges, etc.	2,770,000	.6
Total	$434,865,000	

*Comercio Exterior, Secretaria de Hacienda, Cuba, 1924.

Production of Cuban raw sugar for the 1924–1925 crop amounted to nearly a third of the world's output of cane sugar for that year, or 5,125,970 long tons, against a world tonnage of 15,561,092.[3] The rapid extension of the area devoted to the crop during the last quarter century has brought the gross output of sugar to a point where it is doubtful if any other important country can equal its record, at this time, in point of agricultural specialization upon a single crop.[4]

SOME ASPECTS OF THE SUGAR CANE INDUSTRY

It is generally recognized that the fabrication side of the industry has kept efficient pace with the steady increase in the available supply of raw materials from the fields during this period of huge expansion. From the agricultural standpoint, however, the situation is different. Extensive rather than intensive methods have prevailed. The fact that sugar is really produced in the field rather than in the mill has been lost sight of on many of the great centrals, and primitive and inefficient methods are in wide use, both in the cultivation and in the selection of land for planting. When the yields have run down, especially on the plantations of the newer regions of the eastern provinces, it has been the custom to throw the land out of cultivation and to clear and plant new land. This planting has been done by sticking the seed in holes punched into the unplowed stump land with a sharpened stick or crowbar.

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[3] Story of Sugar in Hawaii, Hawaiian Sugar Planters' Association, Honolulu, 1926.

[4] Compare R. H. Whitbeck: Geographical Relations in the Development of Cuban Agriculture, *Geogr. Rev.*, Vol. 12, 1922, pp. 223–240.

No attempt has been made to select the better lands. The savana areas have generally been avoided, it is true, but this about covers the limit of soil selection according to crop adaptability. Even in 1926, to give an example, some large plantings were made on an old plantation in one of the middle provinces, on a site where toxic salts whose presence had not been ascertained in advance by the management, killed the cane in its infancy.

The low acreage yield of sugar in Cuba is due to a variety of causes, some of the most important of which, at least from the cultural side of the equation, are: (1) The use of too much inferior soil, (2) inadequate preparation of the fields before planting, (3) failure to cultivate and control weeds in too many fields after planting, (4) failure to refreshen with fertilizers long-used fields on certain impoverished but not "worn out" lands, and (5) failure to remedy the imperfect drainage of lowlands by adequate canaling and ditching. Plant diseases, insects, and sometimes droughts take toll of the crop also; but these deterrents constitute problems that often cannot be controlled so readily as the phases of land usage and cultivation mentioned. Recent studies have shown that in many instances damage charged to root diseases is actually of a non-pathogenic nature, representing simply unfavorable soil conditions such as can be remedied in many cases by proper cultivation or drainage.[5]

A survey of the soil situation in Cuba by the soil-type method shows conclusively that a large increase in the average yield of cane can be brought about by extensive reorganization of the fields for the purpose of taking out of cultivation certain inferior soils and turning these to use for pasture or timber. The ills of the Cuban cane grower are not going to be remedied by tenacious adherence to old methods on impoverished land or on inferior new land, nor is there going to be relief for all through the magic of fertilizers indiscriminately applied. Some of the old methods of cultivation are good under certain conditions, and the use of fertilizers of the right kind in the right place and in the right way will contribute considerably toward a betterment of yield; but they can never take the place of needed tillage and drainage.

It is contended by some growers that their sugar mills must be kept grinding at capacity. It is obvious, however, that the milling season should be shortened if going through the full season means that much cane from poor fields is to be converted into sugar at a loss. It is common knowledge that some centrals strive for tonnage output with too little regard for cost. In order to break last year's record or to exceed the output of some rival mill (rival in the sense of output only), cane is frequently brought from other plantations, transported at high freight costs, and finally milled at a loss. Practices of the kind are reported as being due in some instances to the psychological effect high tonnage output has upon those who have to do with the financial obligations of the plantations. Such a situation, of course, is merely an unfortunate one, without real geographic or economic basis.

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[5] J. A. Faris and R. V. Allison: Sugar Cane Root Disease in Cuba, *Phytopathology*, Vol. 17, 1927.

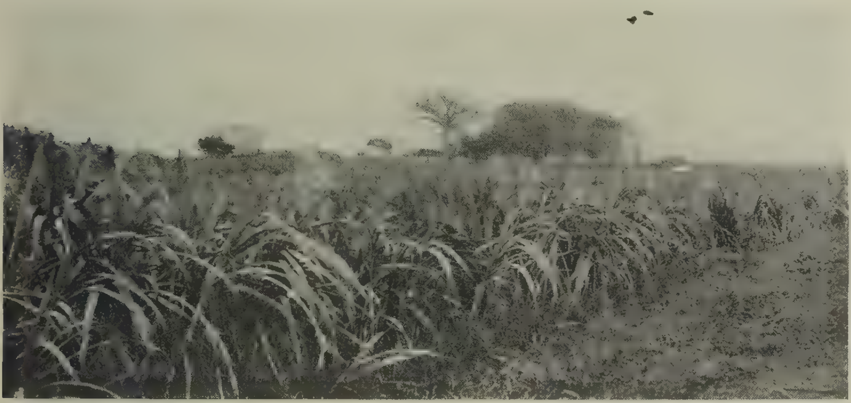

FIG. 12—This field of cane has not been replanted for 80 years and is still producing good crops. It is on rich alluvial soil.

NEED FOR BETTER SOIL USAGE

In undertaking to deal with the varied soils according to their specific needs and adaptations, it is first necessary that they be accurately classified and defined. Without this information there will be continued confusion as to soil identity in outlining and controlling farm management practices; virtual impossibility on some farms of correctly utilizing the results of fertilizer, tillage, and varietal tests that may be carried out upon the important soils of the island; and frequent uncertainty in the matter of deciding what is and what is not pasture or forest land rather than cane land.

Two examples will be given of widespread misjudgment of soil needs in Cuba and the costly results of such ignorance. A considerable number of plantations are carrying on deep plowing and knifing with steam cable plows on soils of the very extensive *Bayamo* group, which types have at or near the surface of the ground heavy, putty-like clay that is exceedingly plastic and sticky when wet. This disturbed material with a few soaking rains flows back to its original state of density, so that the effects of the expensive tillage are completely obliterated, save where troublesome *paraná* (Pará) grass has been destroyed by the operation. Such a soil in southeastern Santa Clara Province, which had been knifed and cross-knifed to a depth of about 30 inches and then plowed to 18 inches, gave a crop of plant cane that was not worth cutting, while the cost of tillage had been approximately $60 per acre.

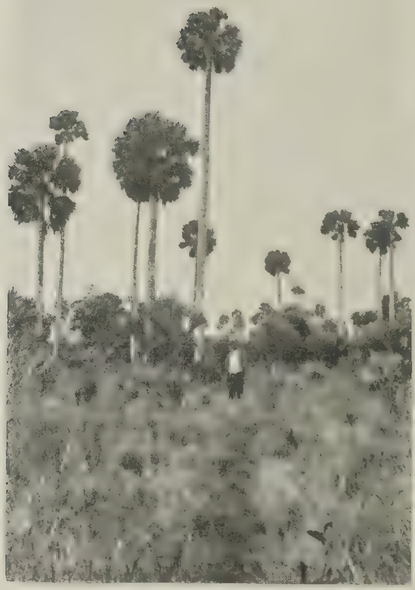

FIG. 13

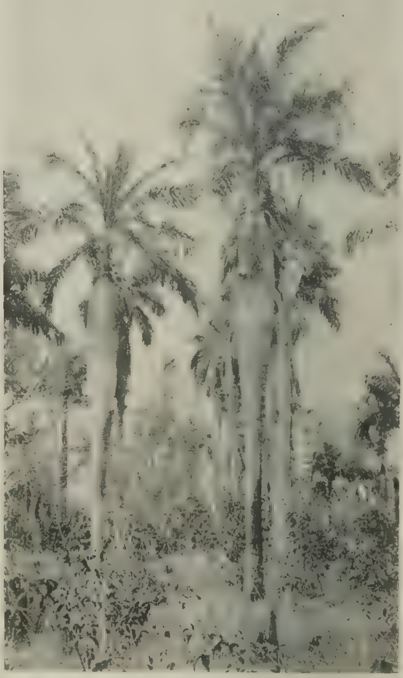

FIG. 14

FIG. 13—Vegetation on stiff clay savana, where the salt content is rather high. The tall tree is the very common *Palma cana*, closely resembling the cabbage palmetto of Florida.

FIG. 14—Corojo palms on semi-savana of rather low productivity in central Cuba. This thorny species produces an edible fruit, and its leaves are used as a textile.

In case of clays of the soils of the *Truffin* group opposite conditions prevail. When moist, this clay is moderately friable; on drying, the subsoil assumes a condition of hardness that is almost stone-like. Extreme desiccation takes place after the rains have ceased. By the latter part of the dry season no active moisture can be detected down to depths of four or five feet, as a rule; and as a result young cane parches severely. Only a few planters have learned that deep knifing in the dry state shatters the hardened subsoil clay to form a permeable subsoil condition favorable to storage and retention of moisture.

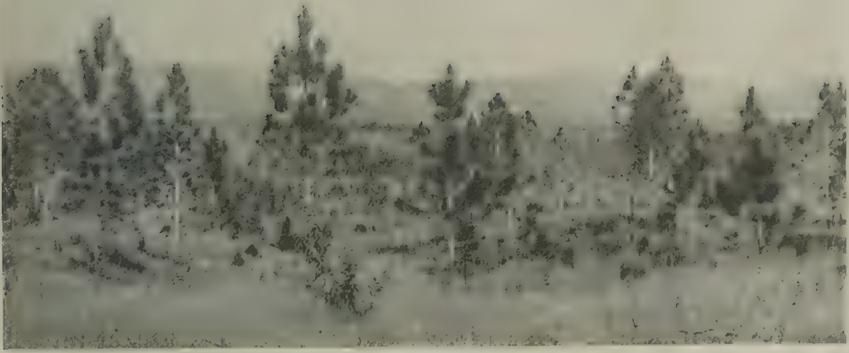

FIG. 15

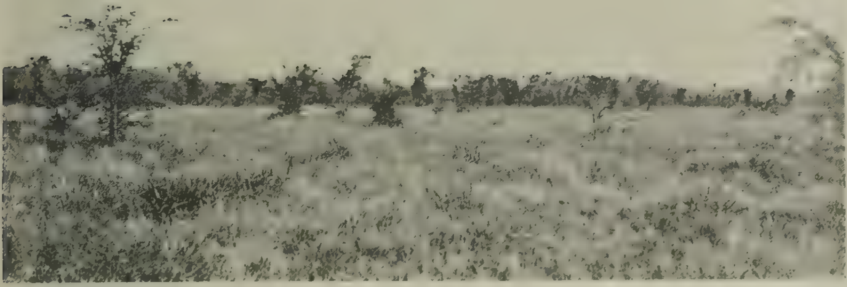

FIG. 16

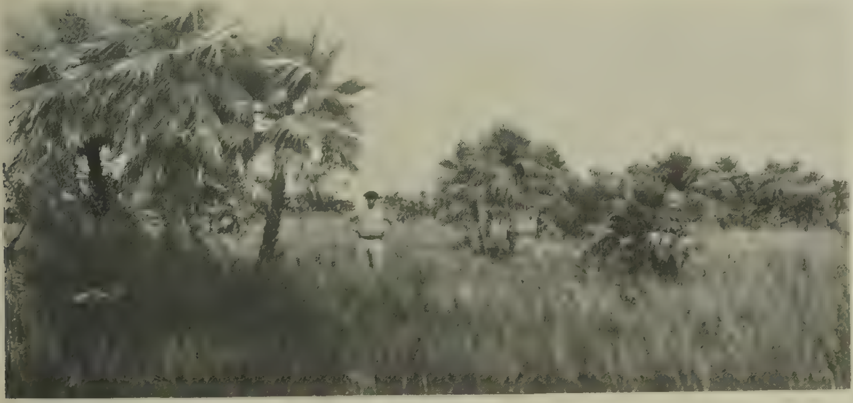

FIG. 17

FIG. 15—Pine, *paralejo* bushes, and wire grass on the thin soil of the piedmont region in western Cuba. Cordillera de Guaniguanico in background.

FIG. 16—Savana of extraordinarily intractible black clay that defies efficient cultivation and is best adapted to grazing.

FIG. 17—Sandy coastal savana, very poor soil for cropping, but producing considerable grass (*espartilla*). The palmettos are known as *juta de Guanabacoa.*

With this sort of treatment these clays, at least temporarily, can be converted into what amounts to a new soil type, one that gives three, four, or five times the yield of cane. How long the effects of this good treatment will last has not been definitely determined, but it is known that several good ratoon crops can be counted on where the work is effectively done. In 1926 cane was harvested from thousands of fields including this kind of land, often where the yield was not more then five or six tons an acre, or scarcely enough to pay the cost of cutting and hauling it to the mill.

It is not to be understood that all of Cuba's cane lands consist of these unfavorable clays. Actually there are extensive types of exceedingly desirable sugar-cane soil, such as the deep friable clays of black, brown, and red color: *Camagüey*, *Santa Clara*, *Matanzas*, and other types. These give excellent yields wherever weeds are properly controlled. The vast flat plains of friable red clay of the Matanzas type, representing one of the most extensive soils of the island, have been in cultivation for several generations throughout Habana and Matanzas Provinces. Some fields which have been in cultivation for a hundred years are still producing 15 or 20 tons of cane per acre, although fertilizer or manure has never been applied to some of the areas.

These red lands are truly remarkable. The soils often extend to depths of 20 feet or more without visible change in their physical makeup and show essentially no change from the surface down, either chemically or physically, when submitted to analysis. There is so little stickiness that plowing can be done within a few hours after torrential rains. There is very little run-off, and practically no erosion, even on slopes.[6]

It should be explained that this is one of those peculiar tropical soils, of low silica content and high iron and alumina content, in which the clay particles have come together in floccules, or clusters of grains, in such a way as to give rise to abundant pore space for the passage of water.[7] In the Nipe Mountains of eastern Cuba a deep red serpentine-derived soil of high clay content is nearly as friable as sand and seems to be not in the least susceptible to erosion. It has been so leached that practically all its constituents have disappeared with the exception of iron, alumina, and a little silica, manganese, chromium, and nickel. The type is extraordinarily unproductive as a soil but it is valuable as iron ore. It does grow pine trees and wire grass, however.

Some planters undertake to justify the poor condition of cultivation obtaining on many of the Cuban sugar estates by pointing out

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[6] H. H. Bennett: Agriculture in Central America, *Annals Assn. of Amer. Geogrs.*, Vol. 16, 1926, pp. 63–84.

[7] H. H. Bennett: Some Comparisons of the Properties of Humid-Tropical and Humid-Temperate American Soils, *Soil Science*, Vol. 21, 1926, pp. 349–374.

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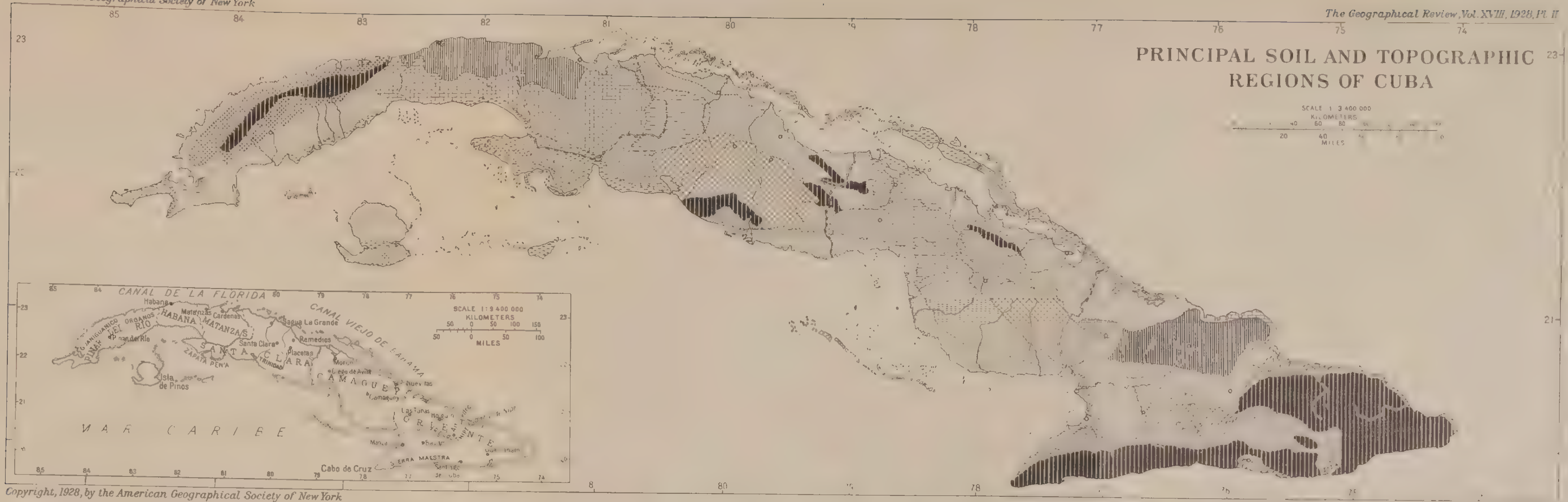
The Geographical Review, Vol. XVIII, 1928, Pl. II



PRINCIPAL SOIL AND TOPOGRAPHIC REGIONS OF CUBA

SCALE 1:3 400 000

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░ **1.** Coastal Plains. Mainly flat and frequently merging into swamp; much land inundated in wet season. Large variety of soils chiefly clays of stiff, impervious subsoils: brown over yellow (*Júcaro*); brown over yellow, gray, and red (*Herrera*); black over yellow (*Zapata*); and *Truffin*. In northwestern Camagüey much stiff, gray alluvial clay (*Yaguajay*); in northeastern Camagüey and northwestern Oriente much black and gray clay over greenish, stiff clay (*Lugareño* and *Tunas*); in northwestern Oriente considerable brown, friable clay of purplish cast (*Chaparra*). The *Chaparra* is nearly all in cane, giving good yields: other clays often have hummocky surface (hogwallow), difficult to keep in good tilth. Much cane grown with rather poor yields on the *Júcaro*, *Herrera*, and *Zapata*, and also on local salty areas. In Pinar del Rio flat and often wet near sea; undulating to rolling and well drained toward interior. Predominantly sandy and gravelly soils of acid reaction and low fertility. Many types like those of southeastern United States. The better drained of these, especially those with reddish, friable sandy clay subsoils (*Greenville*, *Orangeburg*, *Ruston*, and *Pinar del Rio*), produce with fertilizers a fine grade of tobacco. Some good cane on alluvial soils. Considerable hardwood forest locally in east. Some infertile savanas.

▦ **2.** Limestone red lands. Mainly flat plains. Deep, red clay (*Matanzas*); friable and highly permeable; little change from surface downward. Excellent soil, largely used for sugar cane. Locally shallow and stony, better suited to pasture. Considerable red and brown clays (*Perico* and *Truffin*) with tough clay subsoils, highly desiccated and stone-like in the dry season, but on which yields can be greatly increased by deep subsoil tillage.

░ **3.** Rio Cauto-Alto Cedro Plain. Low and flat; some areas imperfectly drained. Mostly heavy clay of black (*Bayamo*) and gray (*Alto Cedro*) color, difficult to keep in good tilth. Extensively used for cane. Some limestone hills, consisting chiefly of *Santa Clara* soils. In places injurious amounts of salt.

☐ **4.** Savanas. Flat, locally undulating. Mainly grass, with palms and small trees locally abundant. Sandy soils and shallow clay over rock, usually of low productivity. Liberally fertilized, well-drained deep sandy lands (*Estrella types*) produce fair crops of cane. The dominant shallow soils, including the peculiar *Mocarrero* sandy types with ironstone hardpan, best suited to grazing: henequen probably could be grown. Little cultivation except on associated patches of limestone. Many small savanas not shown.

☐ **5.** Sandy peneplain, northern part Isle of Pines. Mainly grayish, acid sandy soils, locally containing abundance of angular quartz, over yellow and red clay (*Santa Barbara*); brown sandy soils, with abundance of iron concretions over reddish and yellowish clay (*Nueva Gerona*). Well drained, giving good results with citrus fruits where fertilized. Vegetables grown commercially on moister flats. Vegetation chiefly pine and palmettos. Basal rocks largely quartz schist: several isolated limestone mountains and schist hills.

░ **6.** Southern Interior Camagüey Plain. Flattish to undulating, with low isolated hills. Some flats covered with water in wet season, but generally fair to good drainage. Principal soils; black clay over chalk (*Oriente*), black clay over yellow, limey clay (*Camagüey*), and *Santa Clara*, *Truffin*, and *Matanzas* clays. On the hills some gravelly and stony *Habana* and *Matanzas* clays. Much good cane land. Considerable hardwood forest in places.

▨ **7.** Trinidad Plain. Undulating to rolling, with some hills. Well drained, with considerable good soil extensively used for cane. Predominantly brown clay loam over yellow clay, with gravel and soft sedimentary lime rock beneath (*Palmarita*); chocolate-colored clay and clay loam over red, friable clay, representing old alluvium on benches (*Caracusey*); *Santa Clara* clay and stony clay on the higher positions.

░ **8.** Guantanamo Valley Region. Undulating and rolling with some hills; good drainage. In western part, chiefly brown clay and clay loam overlying interbedded sandstone, conglomerate, and chalky lime (*Palma* types), with considerable *Santa Clara*, *Habana*, and stony clay. In eastern part chiefly brown clay overlying greenish clay derived from greenish shale, with considerable good alluvial soil. Much good cane land. Exceptionally dry climate about Guantanamo Bay; some desert vegetation.

▨ **9.** Gently rolling to hilly. Well-drained brown (*Santa Clara*), ashy-gray (*Habana*), black (*Camagüey*), and red (*Matanzas*) limestone clays. Locally shallow and stony. Deeper types of smoother areas productive and extensively used for sugar cane and locally for tobacco. Some quite stony areas of *Havana* clay produce good cane.

░ **10.** Sagua-Moron rolling to hilly. Chiefly *Habana*, *Matanzas*, *Santa Clara*, *Truffin*, and *Camagüey* clays, gravelly clays, and stony clays. Some exceedingly stony hills in north-central Santa Clara Province. Soils highly varied. Many deep favorable areas used for cane. Much tobacco grown in *Remedios* district on all types of clay, including quite stony lands. Considerable stony land best suited to pasture.

▩ **11.** Gently rolling to hilly. Well-drained brown (*La Largo*) and red (*Limones*) clays derived from igneous rocks, chiefly serpentine, hard when dry. Smoother areas of deeper soil produce fairly good cane. Some heavy tobacco grown. Many shallow and stony areas, now farmed, give low yields and should be turned to pasture. Cattle raising very important in Camagüey-Las Tunas area.

▩ **12.** Foothills or Piedmont Region of Western Cuba. Rolling to hilly peneplain of thin gravelly and sandy soil of low productivity. Little used except for pasture. Pine and wire grass. Tobacco on alluvial soils. Some isolated hills, 1500 feet elevation.

▥ **13.** Habana-Matanzas Hill Region. Higher elevations 900 to 950 feet altitude. Mainly *Habana*, *La Largo*, *Limones*, *Matanzas*, and *Truffin* clays and stony clays. Considerable deep soil locally, on which fair to good sugar cane is grown. Some trucking and dairy farming. Stony areas generally used for pastures. Some stony soil of the *Habana* type used for fruit, while some exceedingly stony land of the *Matanzas* type gives good yields of henequen.

▥ **14.** Holguin Hill Region. Shallow, gravelly, and stony land underlain by sedimentary and igneous (mostly serpentine) rocks. Much rolling land with deeper soil derived from limestone and serpentine. The more stony soils, as the red serpentine clay (*Holguin*) and the shallower (*Matanzas*, *La Largo* and *Limones*) types, droughty, of low crop value, and best suited for pasture, although henequen might be introduced. Some good cane on deeper soils and fair yields from occasional limey gravelly areas. Some very poor savana, with chalk near the surface and thick growth of palm. Region exceedingly variable in soil, topography, and agricultural value

▥ **15.** Mountains, including Maestra Range (maximum elevation about 8000 feet); the great massif of extreme eastern Cuba, including Nipe and other mountains; Trinidad Mountains; Organ Range; Guaniguanicos. These highlands are rough and include much excessively stony and steeply sloping land of value only for forestry. Many strips in valleys and coves and patches on shouldering positions cultivated by small farmers. The deep, friable, red serpentine soil of the Nipe Mountains, mined for iron ore, is exceedingly poor but supports pine forest and wire grass. In parts of the eastern mountains considerable hardwood forest.

░ **16.** Piedra Hueca. Shallow soil over cavernous limestone. Mainly forested and only useful for timber.

░ **17.** Swamp Lands. Chiefly mangrove swamp (saline clay); deep and shallow peat, as in Zapata Peninsula region, and marl. Peat and marl areas support mainly a growth of saw grass. Permanently saturated and very little used except for wood cut for charcoal.

that the extensive rather than intensive method of production has survived entirely upon the basis of fitness and cheapness and that this plan gives cheaper cane than would be grown under a system involving modernization of the farm methods, because of the high cost of labor that would be involved. This point of view leaves out of account entirely the proposal to eliminate the soils of low productivity and to expend the effort wasted on them upon those types which are known to give much greater response to intelligent treatment.

Tobacco

After cane, tobacco is the leading farm product of Cuba. The high-grade cigar wrapper grown under cheesecloth shade on the well drained land in the Vuelta Abajo district, Pinar del Rio, is said to be the highest-priced tobacco of the world. The growers prefer the quartzose soils with a reddish, friable sandy clay subsoil. The product from these selected lands, when grown with right care, gives the desired taste and aroma.

Filler tobacco is grown in the sun and does not receive nearly so much attention as the wrapper, even though it constitutes the bulk of a finished cigar.

Some good tobacco also comes from the red clay soils of the Partito district near Habana. That from the Vuelta Arriba district in the province of Santa Clara is grown on a large variety of soils, ranging from the brown *Santa Clara* clay to the black *Camagüey* clay. Fertilizers are not used here, and the product ranks much below that of the more westerly districts, namely, the Partito and Vuelta Abajo.

Other Products and Agricultural Possibilities

Much market gardening is carried on in the environs of the cities and towns, but commercial trucking is restricted. Peppers, eggplants, tomatoes, and lima beans are shipped to New York during midwinter from the sandy lands of the Isle of Pines and from two or three points west of Habana, while some potatoes are shipped from the red lands of southeastern Habana Province. Excellent crops are grown on the well-drained sandy soils of Pinar del Rio and the *Matanzas* red clay north of Ciego de Avila and in a few other localities. There is abundant opportunity for increasing the midwinter shipment of these products. Good grapefruit comes from the Isle of Pines, and oranges of excellent quality come from the red clay of Ceballos and from several other localities. Bananas are exported from the coastal region east of Nipe Bay in far-eastern Cuba.

Henequen is grown commercially on exceedingly stony land near the cities of Matanzas and Cardenas; from this a large amount of cordage is locally manufactured for domestic consumption, and some fiber is exported. There is no good reason why the nation should be content to see the production of this valuable crop restricted to these two localities, when precisely the same soil and other conditions as those obtaining where the crop is now being grown so successfully are to be found over extensive unused areas in other parts of the island.

But for the long dry season and high labor cost, Pará rubber probably could be successfully grown. The trees would thrive on a number of the moist types of friable subsoil character occurring in several parts of the island. On the red soils of the *Matanzas* group, Pará rubber trees would luxuriate under irrigation. These lands are rather droughty, however; and, without artificial watering, flow of latex might be sparing in the dry season.

Cacao and coffee, formerly extensively grown, have fallen to positions of little importance. Within comparatively recent times cacao groves have been cut down and planted to sugar cane. There still are some small *cafetals* in the mountains, producing for local consumption. If the mountain coffee is as good as it is declared to be—and some contend it equals the Blue Mountain variety of Jamaica—there would seem to be possibilities for making this an important crop for export and domestic use.

There are many reasons why Cuba should diversify her crops in a really substantial way. As we have already said, the soils are available and the climate is favorable; furthermore, the Cuban on the farm is a good worker, and the need is very great. Much land that is not suitable for cane, although being used for that crop, should immediately be turned over to increased cattle and hog production as the first important move toward a more balanced type of agriculture. Hogs are very easily raised. The royal palm alone produces enough fruit, an excellent hog feed, largely to increase the production of pork and lard. In addition, corn, sweet potatoes, cassava, and the tropical yam—all of which can be grown easily and abundantly nearly everywhere—could be used very advantageously in connection with increased hog production. Also, Cuba is a good cattle country. Most of the cane crop is carted out of the fields with Cuban bulls. In some localities the raising of cattle for beef has attained large importance, and dairying is of significance near Habana and the other larger cities. Grass and forage crops can be grown nearly everywhere, and rather easily. There appear to be good opportunities for building up an export trade in cattle with Central America and possibly Mexico and parts of the West Indies.

As the writer sees it, the possibility of establishing for Cuba a new economic equilibrium based upon an improved type of agriculture constitutes one of the most attractive and important scientific problems to be found anywhere in the field of agricultural development today.

AN UNNOTICED ANCIENT METROPOLIS OF ASIA MINOR

H. H. von der Osten

Hittite Expedition of the Oriental Institute, University of Chicago

FIG. 1—The ridge of Kevkenes Dagh from the east, crowned by the unknown ancient city. From right to left the elevations are: Keykavus Kaleh, the citadel; Kiramitlik; Gös Baba.

THE "unnoticed metropolis" of this paper is a remarkable site, the existence of which has long been known but which has apparently never been described. Yet it is the site of the largest pre-Greek city of Asia Minor, a city that in its day must have been one of the chief cultural and political centers of the great Hittite Empire that flourished in the second millennium before the Christian era. In the last few years the decipherment of Hittite cuneiform records has greatly stimulated our interest in that Empire and its mysterious and little-known people.[1] Its survivals, however, cover a vast territory, scattered as they are from one end of Asia Minor to the other, and little has heretofore been done to recover and study them.

In the summer of 1926 the Oriental Institute of the University of Chicago began a campaign of research in the field. The first step was the making of a preliminary archeological survey in the basin of the ancient Halys River, the Küzül Irmak[2] of today.

FIRST VIEW OF THE CITY ON THE KEVKENES DAGH

One evening during the course of the preliminary explorations of 1926 on our way back to Yozgad we passed a remarkable site which appears on Kiepert's map of Asia Minor[3] simply as a mountain called Kjerkjanos Dagh, our Kevkenes Dagh, with nothing to indicate the imposing ruins awaiting us. The inhabitants of the village at the foot of the mountain told of a *büyük kaleh*, big castle, at its summit and a *chòk büyük sur*, very big wall, reaching from the castle itself to Kiramatlik, "the place where there is pottery," a still higher point in the lofty mountain ridge nearly 1.5 kilometers southward (Figs. 1 and 5). Though it was already late we climbed up to the "castle," whence we had a comprehensive view of the wide plateau between the two elevations just mentioned, the entire plateau being surrounded by the ruins of what must have been a great wall built of large stones. The place was of such magnitude and importance, and the interval before sundown so brief, that we abandoned any thought of even a sketchy survey, promising ourselves to return the following year.

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[1] For a summary of our present knowledge of the Hittite Empire see H. H. von der Osten: Explorations in Hittite Asia Minor, *Oriental Institute Communications No. 2*, Univ. of Chicago Press, 1927. See also D. G. Hogarth: The Hittites of Asia Minor, in: The Cambridge Ancient History, Vol. 2, 1924, pp. 252–274.

[2] Turkish names transliterated according to the system now being worked out by the Oriental Institute.

[3] Karte von Kleinasien, 1:400,000, Berlin, 1902–1906.

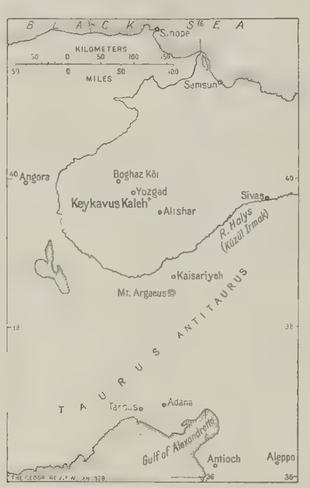

FIG. 2—The general location of the ancient city of which the citadel is now known as Keykavus Kaleh.

Our first year's investigation in the region had made so obvious the need of systematic archeological work that the General Education Board granted an appropriation for the support of a five years' campaign of Hittite research in Asia Minor.[4] In pursuit of these plans the Institute selected for excavation in 1927 an unidentified but extensive site near Alishar, about 128 miles (205 kilometers) east-southeast of Angora, in the heart of the Hittite country, and not far from the ancient capital, now known from the name of the neighboring modern village as Boghaz Köi (see Fig. 2). The necessary concession for excavation was granted by the Angora Government, which throughout has shown a spirit of cordial coöperation, and the expedition established itself in the field late in May. From Alishar it was possible to make excursions to neighboring sites and ruins noticed or discovered during the preliminary work of the preceding summer. Among these was a visit to the site on the Kevkenes Dagh, which was undertaken at the first opportunity.

SECOND VISIT TO KEVKENES DAGH

Accompanied by Mr. Erich Schmidt, of our staff, and Tachsin Bey, our Turkish dragoman, I traveled over the road taken the year before towards the impressive ridge of the Kevkenes Dagh. The Anatolian sun, usually so brilliant, was hiding behind a screen of black clouds from which rain was descending upon the villages in the distance, a fact which unfortunately interfered with our photographic record. We passed through Karavilly, one of those pleasant, clean, flat-roofed little Anatolian villages, which came to life at our approach. Ragged little brown children came tumbling out of the gates, and among other strange characters appeared a *hodja*, the village priest and teacher, who alone is still permitted to wear the fez and turban. Our curiosity was roused by a peculiar long, flat rock resting on two smaller ones—we had seen similar rocks in nearly every village. Tachsin Bey informed us that this is the "death stone" of the village, upon which are laid the bodies of the dead before their burial.

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[4] Additional support for the first year was also contributed by a group of interested friends: Mrs. Murray Crane, Mr. Henry J. Patten, Mr. James A. Patten, and Mr. Frank G. Logan.

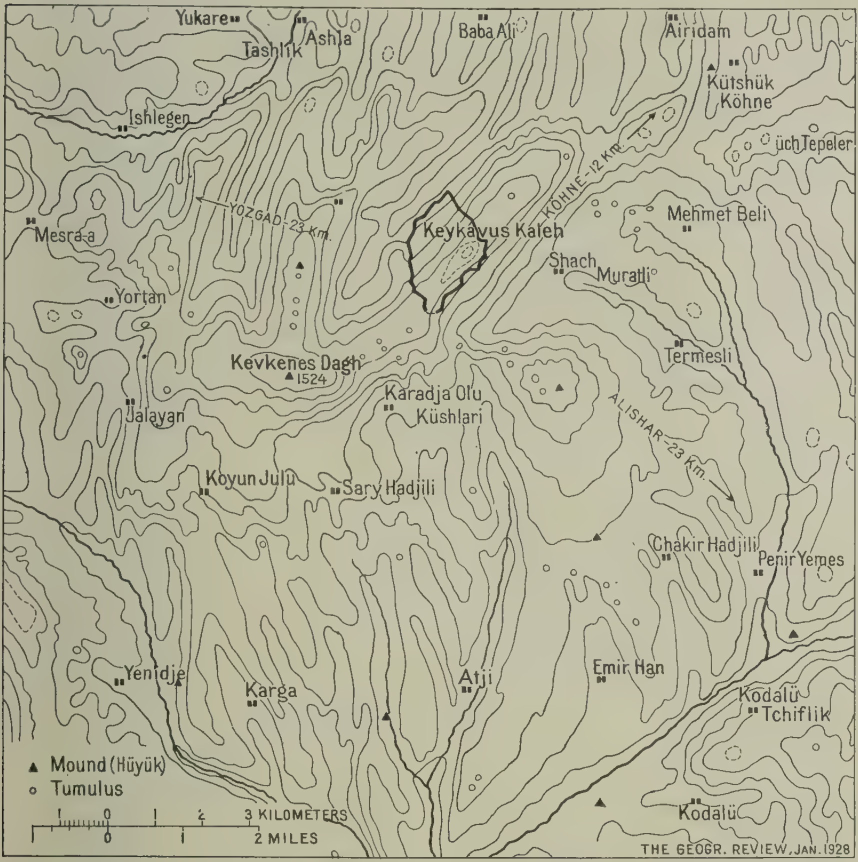

FIG. 3—Sketch map showing the site of the ancient city in relation to neighboring antiquities and modern villages.

In the next village, Kerbiyeh, we sought in vain the explanation for the pear-shaped lava rocks resting on the corners of certain roofs, and also employed as gravestones. We had observed similar stones in other villages. Their meaning still remains a mystery to us. At Yazili Tash ("inscribed stone"), the next village, we rephotographed the late-classical architrave we had seen the year before. Halfway between Yazili Tash and the village of Penir Yemes ("there is no cheese"), a good-sized ancient city mound called by the natives Chadür Hüyük ("the tent-shaped *hüyük*," mound) is visible from the road. After passing Termesli we reached Shach Muratli, a village at the foot of the long mountain range on which was situated our goal.

Half an hour's hard climb over slippery rocks and grass brought us to the ancient city enclosure, beyond which we continued to climb until we reached the top of the *kaleh*, some forty meters higher (Fig. 4). From this point the panorama is impressive. One looks far over the city and across the surrounding plains. To the west, toward Yozgad, and to the north is a mountain landscape, the higher peaks being surmounted by tumuli. Southward lies the irregularly divided plateau upon which is situated the larger part of the ancient city we had come to survey, stretching out to the elevation of Kiramitlik, behind which is visible the large tumulus of Gös Baba ("eye-father"), perched on the southernmost tip of the Kevkenes Dagh. Still farther southward and eastward extends the wide and fertile plain through which flows the Konak Su with its many tributaries. Hundreds of villages dot the plain and the hills with their groups of flat-roofed houses huddled together. The villages nearer at hand are clearly visible, but those at a distance stand out by reason of the groves of trees among which they nestle, such groves in this region being found only near human settlements.

Numerous tumuli can be observed on the mountains as well as on the slopes of the Kevkenes Dagh and on smaller elevations in the plain, where I could also distinguish at least five ancient city mounds (Fig. 3). From the plain, about twenty-three kilometers away, emerges the Sivri ("points"), a steep mountain, near which one could discern the site of our own *hüyük* and excavations. Limiting the view beyond the plain to the east lie the Chomak Dagh and a range of high mountains, with groups of tumuli near Terzili Hammam; while to the southeast also may be seen a large part of the high plateau south of the Konak Su, with the tumuli near Battal and the city mound of Sarnen Ören. And finally, far away beyond all these, almost floating in the clouds, rises the vast pyramid of Erdjas Dagh (Mt. Argaeus) near Kaisariyeh, its peak snow-capped.

As to the silent ancient city immediately before us, it is nothing short of imposing. The surrounding walls, which when viewed from the *kaleh* at the easternmost angle of the city appear like long welts of piled-up rocks, enclose an area approximately three times the size of Boghaz Köi,[5] the ancient Hittite capital. The great expanse of ruins, once a city teeming with the life and resounding with the voices of a powerful people who dominated most of Asia Minor, now lies mute and barren. A few scrub trees, stunted by the harsh winter winds

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[5] See Otto Puchstein: Boghasköi, die Bauwerke, Leipzig, 1912, Pl. 1. The north-south length of the enclosure of Boghaz Köi is about 1450 meters, and the greatest width east and west about 1150 meters. The area is shaped roughly like a shield.

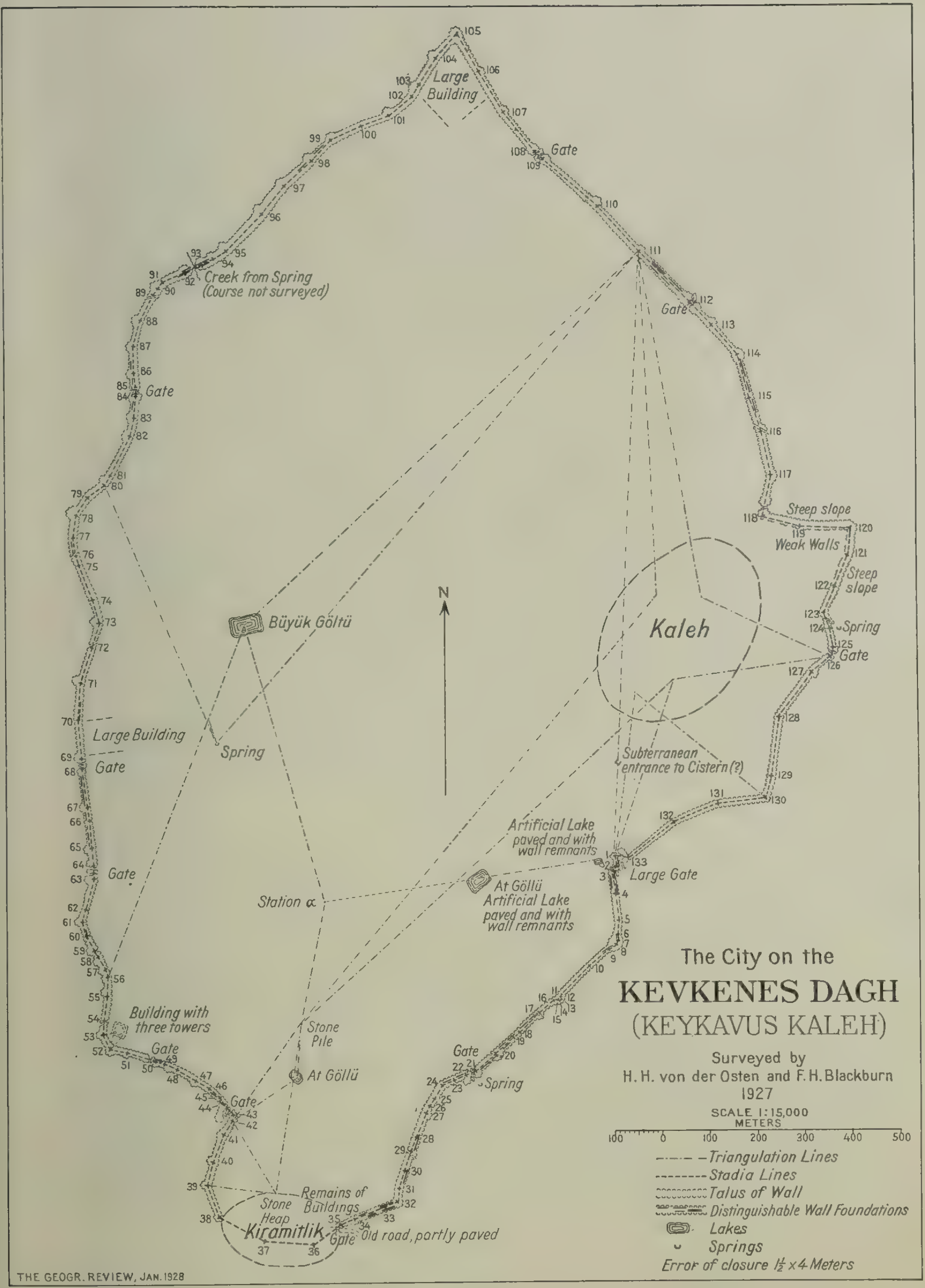

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FIG. 4—Map of the main enclosure of the city on the Kevkenes Dagh.

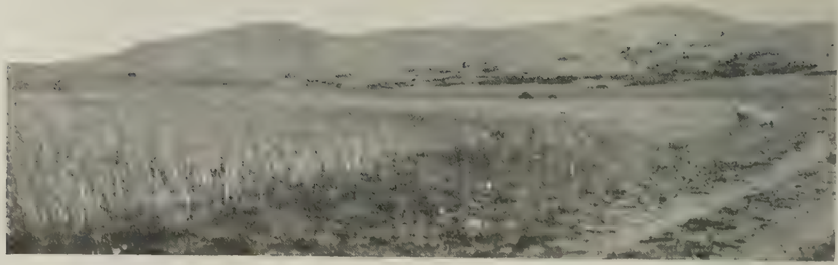

FIG. 5

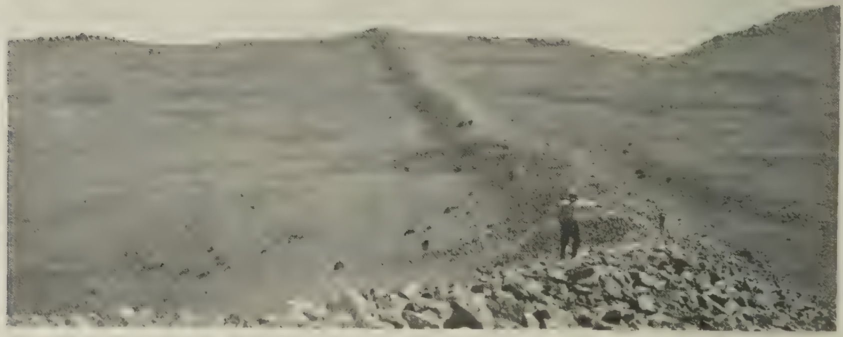

FIG. 6

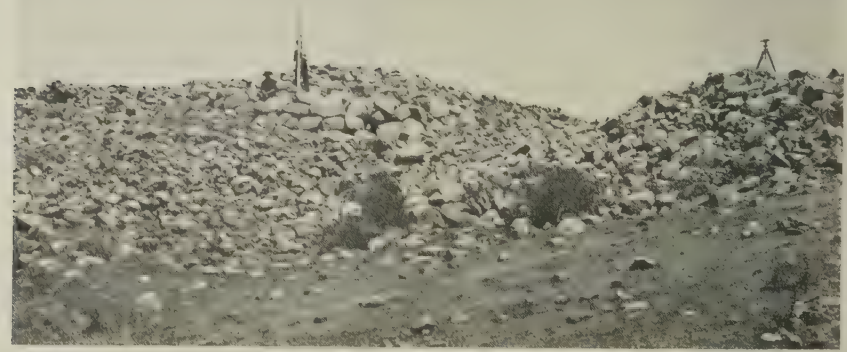

FIG. 7

FIG. 5—The ancient city from the east, with the village of Shach Muratli at its foot.
FIG. 6—Looking southeast along the northeast wall from station 106 to station 111.
FIG. 7—Ruins of gate in the west wall at stations 84 and 85.

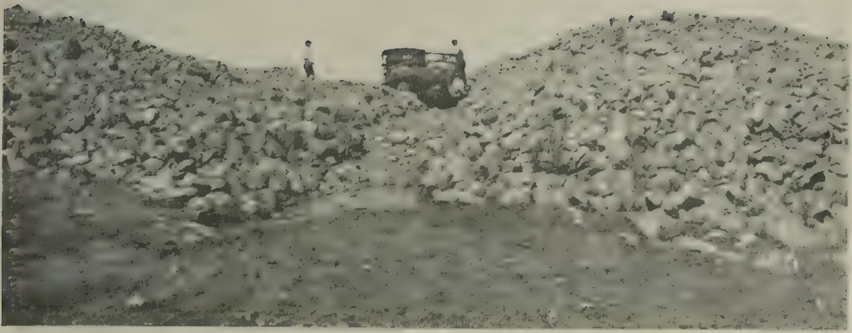

FIG. 8

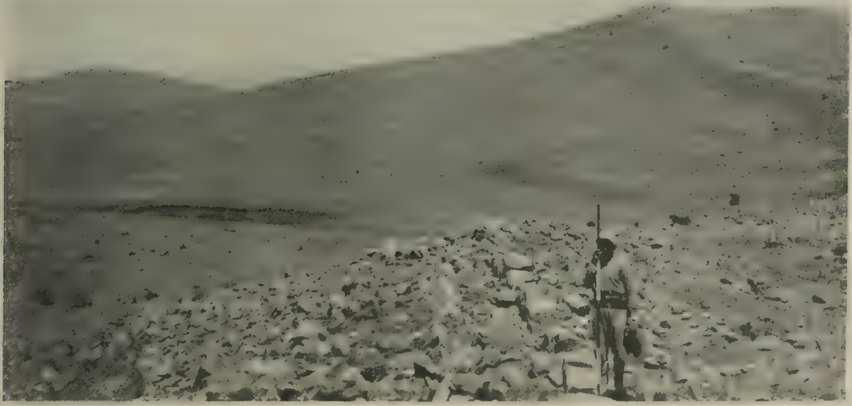

FIG. 9

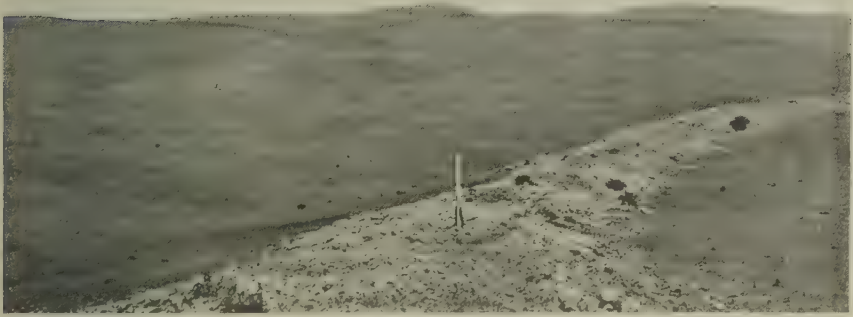

FIG. 10

FIG. 8—Gate in the east wall at station 112.

FIG. 9—The western wall near station 76.

FIG. 10—The present widespread condition of the fallen walls on the west of the city, as seen from station 71.

which sweep over this now deforested region, timidly sprout from amongst the jumble of rocks at the base of the *kaleh* immediately below us. Otherwise the great enclosure is a picture of desolation. Northwest from the steep *kaleh* the ribbon of tumbled wall stretches away in gentle undulations until it reaches what was the northernmost limit of the city (see Fig. 4, station 105; also Fig. 6), where it turns back sharply upon itself southwestwards, and from the *kaleh* can be seen, almost a mile away, continuing southward until it reaches the abrupt, steep slope of Kiramitlik which for a short distance serves to break its continuity (stations 35 to 38). East of Kiramitlik, the city's southern limit, the wall is resumed, winding sharply northward again toward the *kaleh*, to complete an enclosure nearly a mile in width and over a mile and a half in length (1520 meters by 2564 meters).

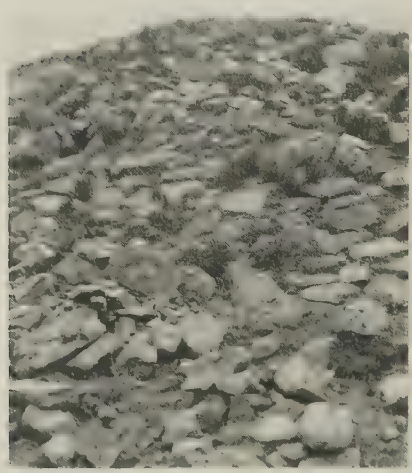

FIG. 11

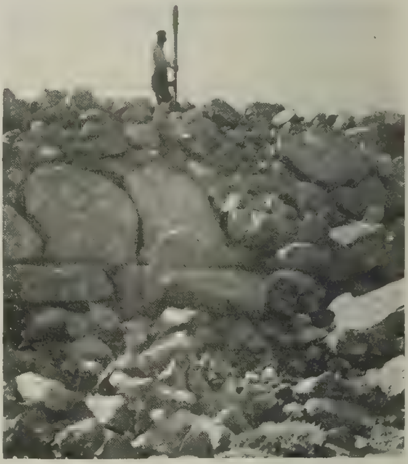

FIG. 12

FIG. 11—Stone pavement on the slope of the citadel (Kaleh).
FIG. 12—Example of the east wall near station 112. It rests on a massive stone foundation.

The enclosure walls follow the natural elevations rising from the plateau; and within them well-marked contours of ancient structures are visible, although here and there at higher points the bed rock comes to the surface. On the *kaleh* itself room divisions are well defined by rectangular lines, once building walls but now simply piles of stones. In some places can still be seen remnants of the actual walls, with stones still *in situ*, the thickness of the wall at such points measuring about 1.85 meters.

SURVEY OF THE RUINS

We selected a place which would be suitable for our tent when we later returned for the survey and took some preliminary notes to assist us in this latter task. Returning a week later accompanied by Mr. Frank H. Blackburn of our staff at the Alishar excavations, we were able after three days of hard work to map the main enclosure of the great city and make the necessary notes.

The survey of the wall was achieved by "shooting" 133 stadia lines. At each station thus secured the width and height of the fallen wall was measured, as well as the dimensions of any other adjacent construction. The height of the now fallen wall averaged 2.50 meters, sometimes attaining 3.50 meters, while in its present tumbled and dispersed condition the width of the débris varied between 10 and 16 meters, the sections near stations 90 and 105 bearing evidence of having been especially massive. Near the slope to the east (stations 118 to 122) only very scanty remains of the wall are to be found. In addition to the stadia lines a few triangulation lines also were "shot," in order to locate some artificial lakes and a subterranean spring at the foot of the *kaleh* (Fig. 13). Of interest was the fact that on the Kiramitlik side the wall was for some distance discontinued (stations 35 to 38). At the same time we prepared also a small map (Fig. 3) showing the general situation of the city and its relation to surrounding tumuli and *hüyüks*.

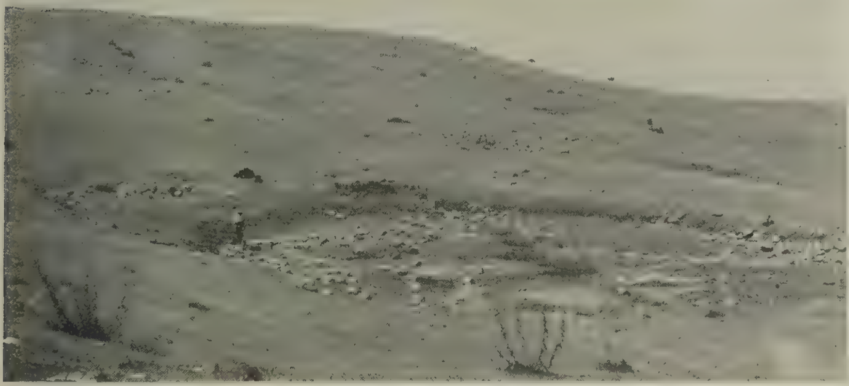

FIG. 13—Artificial lake basin (at Göllü) inside the city wall. Part of the ancient water system.

Closer investigation of the outer wall, as partially preserved in some places, revealed that it was built upon a massive stone foundation some 5 or 6 meters thick at its top (see Fig. 12). To determine the original thickness at the base of the foundation would have required the removal of much fallen masonry, often consisting of very large stones. The angle of the outer slope of the foundations averaged about 60 degrees. Upon this foundation was built the city wall, which varied in thickness from 4 to 4.5 meters.

Protective towers had been built at irregular intervals, usually at points of obvious strategical or tactical advantage or near gates (stations 59 and 89, and Figs. 7 and 8). I found only one tower whose walls were in the least preserved (station 52); all the others could be recognized only as great heaps of stones which had fallen outward from a structure of indeterminate height, the stones in some instances having tumbled to a distance of 17 meters from the actual tower wall. Apparently the towers were round or, at least, had rounded corners.

Of the large gates, only two are sufficiently preserved to enable us to discern something of their architecture (stations 1 and 84). In the case of the gate near station 84 the foundation walls of the two large, round-cornered gate towers are still visible (Fig. 7). On one occasion, in returning to our car we took another route and had to climb down over some 60 meters of refuse and rocks, the talus of the *kaleh* or castle itself. At several points we noticed that the slope of the elevation on which the *kaleh* was built had been paved with large stones (Fig. 11). Without excavation it is difficult to determine how far up into the talus the bed rock reaches.

The potsherds seen on the surface of the ruins are of a kind usually designated as "Hittite," with red or brown-red decoration on a grayish-white or buff-colored slip. Other sherds were simply plain buff and plain red ware. Interspersed among them were great numbers of Roman and even Byzantine glazed ware.

Importance of the Site

As to the origin and history of this city, or regarding its possible name and identity, I would not venture to hazard any premature statement at this time. I would only call attention to the fact that the character of its walls, the rounded corners in much of the construction, and the slope of the foundation walls, are reminiscent of the ruins at Akalan, near Samsun; while the general emplacement of the site reminds one of Boghaz Köi. In other respects, however, this city on the Kevkenes Dagh is not only very different from Boghaz Köi but encloses an area three times the size of the latter.

This city so spacious and so extensively fortified may well have been a long-forgotten rival of Boghaz Köi, lying behind the chain of mountains visible to the west; and it goes without saying that even the partial excavation of the place would yield splendid results. So large is the site that a campaign of less than seven or eight years would be of comparatively little use. Even a detailed survey of the surface remains would require at least six or seven months' work by a staff of experienced field workers.

THE GEOGRAPHICAL STUDY OF SETTLEMENTS

EXAMPLES FROM ITALY, GERMANY, DENMARK AND NORWAY

Hans Wilson Ahlmann

LEAVING the pleasant gardens and populous coasts of northern or eastern Sicily for the interior, a very different country is entered. For hours one can travel on the railroad without seeing men or their dwelling places. In winter the countryside is of a prevailingly brown or grayish tint, monotonous, desolate, bare: deforestation has created a steppe-like landscape. Here and there a stone hut hides its miserable poverty behind a clump of opuntias. A slit in the wall serves as a window; through the open door is seen a child with tethered goat. In the fields a solitary peasant guides a couple of oxen attached to a primitive plow. No other traces of human life in the fields. To discover such one must look up to the mountains and hilltops. Here the people live in towns, close-piled masses of gray stone houses.

Now turn to the country about Naples, the extraordinarily fertile Campania Felice. Here one can travel for mile on mile by a well developed system of tramways. Each town resembles the others so much that the map must be closely followed to know where one is. The towns are sharply divided from the fields but sometimes are so close together that you can call from one to the next, though because of the luxuriance of trees and vines no houses can be distinguished. The buildings front on the streets as solid blocks of masonry. Not until the courtyards are entered do you see that people dwell there and live by farming, or rather gardening. There are the stores from the harvest, there stand tools and wagons, donkeys, and in the better class establishments, cows; everywhere chickens and pigs and a hopeless jumble of people and rubbish. The town is purely rural in character, a big village.

Settlement Regions

Such are two types of South Italian communities. I shall have more to say of them later. Here I wish to emphasize the eloquence of such geographical facts, for they are the synthesis, the crystallization, of the civilization of the region, the complex of the natural and man-made phenomena of the land. It is the purpose of this paper to urge the study of settlements, as geographical entities. How are human groups disposed over the earth, what are the distinctive characters of their establishments,[1] what their origin and evolution, are they comparable, can any principles of development be traced in the multiplicity of forms?

Of the factors that determine the character of human settlement the most important, in my opinion, is climate, and next come geologico-topographical conditions and the degree of material culture. Climate plays a decisive part by affecting the supply of water and the nature of the drainage system, by determining the nature of the vegetable world and the kind of the cultivated plants and, in consequence of this, the character of the agriculture; moreover, it exercises a great influence on the mental and physical vitality of the human inhabitants and has some effect also on the topography. Mr. Aurousseau discusses similar factors but with a different objective in his article on "The Arrangement of Rural Populations."[2]

On the basis of a synthesis of the conditions which these facts express the territories of the world can be classified into different settlement regions. It is scarcely possible at the present stage to make even a preliminary scheme for such a classification: it is a goal for future study. Among the territories which I shall discuss here Italy, or rather peninsular Italy and especially its southern districts, can be classed as belonging to the subtropical, dry-summer climatic region, where horticulture plays an important rôle; Germany and Denmark, to the humid-temperate, cold-winter climatic region, where agriculture has its highest expression, with intensive cattle breeding and dairying and, in Germany, universal industrialism; Norway, to the pine-forest section of the subarctic climatic region with stock raising and more or less scattered but well organized agriculture.

Settlement Series on a Topographical Basis

Within each climatologically determined settlement region are found areas of such varying topographic character that settlement presents marked differences of form, grouping, location, and development. In the course of its evolution it exhibits stages which bear a definite relation to each other and which I have called settlement series (*Bebyggelseserien*). Tentatively I recognize the following:

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[1] Vidal de la Blache and the French geographical school use the term "établissements humains." Aurousseau says "each natural region tends to develop a characteristic form of arrangement of its rural population" ("The Arrangement of Rural Populations," *Geogr. Rev.*, Vol. 10, 1920, pp. 223–240). Demangeon points out that the farmstead "est l'éxpression, modelée par les siècles, de la vie rurale" and "donne la solution d'un problème vital qui est de savoir comment s'établiront les rapports réciproques des hommes, des bêtes et des biens" (*Ann. de Géogr.*, Vol. 29, 1920, pp. 352–357).

[2] See footnote 1. After this paper had been sent in for publication, A. Demangeon's scholarly paper "La géographie de l'habitat rural" appeared in the *Annales de Géographie* for January and March, 1927. He discusses the reasons for compact and dispersed rural settlement. I have the pleasure of noting that many of the views which he takes as a basis for the geographical study of settlement agree with mine expressed here, especially as regards the necessity of study of historical development. In the application of these views we follow different paths; which does not, however, mean that our goal is not the same. See also the note "The Study of Rural Settlement," *Geogr. Rev.*, Vol. 16, 1926, p. 329.

1. General series in regions of normal fluvial erosion, with the exception of (2).
2. Mountain regions of young physiographic stage where a well defined horizontal zoning of climate and life obtains. A subdivision of this class includes glacially eroded mountains.
3. Coastal or littoral series.
4. Dry regions series.
5. Volcanic series.

The scheme here submitted rests on the conception of the whole process of settlement as a great unified complex; a living thing, constantly changing, advancing, retrogressing. However great may be the differences the settlement may show between the different series, however various may be the forms it assumes, it nevertheless seems to me certain that, on the whole, man takes possession of the country for settlement in a similar manner within regions where the dominating conditions in physical geography are similar and when men have there attained a similar degree of civilization. The scheme likewise is based on historical principles; for the present can only be understood by the past. I believe the basic idea is sound, and I hope from the analysis of individual regions to reach a final synthesis. O. Montelius instituted the excellent system of typological research in the realm of archeology. A similar method has its applications to the study of settlement.

The Subtropical Dry-Summer Region of Italy[3]

A typical subtropical dry-summer region is Sicily and the three southern provinces of the peninsula—Calabria, Basilicata, and Apulia. Marginal to it is Campania. The region includes a variety of topographic types; its unity lies in the summer drought which with high temperatures causes a shortage of water and in many cases makes irrigation a prerequisite to any intensive cultivation. Fall and winter rainfall are usually violent, and the dry watercourses of summer become raging torrents whose erosive power is heightened in many instances by the nature of the rocks and the deforestation, long in progress. Morphological changes are going on at an extraordinarily rapid rate. This is notable in the case of the so-called *fiumare*, ravining, to which is added the frequency of landslides and earthquakes, making unstable even the basis of settlement, the earth.

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[3] Sicily, Calabria, Basilicata, and Apulia have been treated in more detail in my memoir entitled "Études de géographie humaine sur l'Italie subtropicale" (*Geogr. Annaler*, Vol. 7, 1925, pp. 257–322; Vol. 8, 1926, pp. 74–124, Stockholm). Reference may be made to that work for further information and for some account of the literature of the subject.

The olive and the vine, modest in water requirements, are characteristic. Most intensively exploited are the irrigated orchards of oranges and lemons. In Sicily and on the Calabrian coast sugar cane and cotton thrive, though neither is grown to any extent.

The region is particularly adapted for a study of the evolution of settlement because of the antiquity of its civilization and the vast literature available thereon. Progress of the general settlement series may be summed up in the following stages, beginning with the point when the population became sedentary by the introduction of agriculture:

1. Human establishments concentrated in agglomerations on the heights, the inhabitants being agriculturists.
2. Descent to the cultivated fields below the heights.
3. Dispersal of the population in the fields.
4. Development of towns, i. e. of a population not entirely dependent on agriculture.
5. Growth of the large cities drawing on a vast hinterland.

In subtropical Italy the series shows a characteristic ebb and flow, advance and retrogression; and some primitive features remain today. It shows concentration of dwellings in towns and villages, their hilltop location, and the large numbers of the population dependent on the soil for subsistence.

Historical Development of Sicilian Settlement

Going back to pre-Hellenic times we find settlements in Sicily on the tops of mountains and hills. Two well known towns, out of a long list of such settlements, are Eryx and Henna. The site of the former was the summit of Mt. Eryx, 751 meters high, in the west of the island. At the foot is the modern dispersed but dense settlement whose inhabitants still go up to the ancient site, now occupied by the village of S. Giuliano, for religious festivals. Henna, 997 meters high in the center of the island, is the modern Castrogiovanni. The ancient settlements formed islands overlooking the thickly wooded and ill-drained valleys; around were clearings of cultivated fields; their roads, *strade di spartiacque*, followed the ridges. In the southeastern limestone area of the island the most desirable locations were the bluffs of the deeply cut valleys or canyons.

We know little of the settlement of the interior during the golden age of Greece, for civilization was concentrated in the brilliant cities along the coast. Apparently there was some dissemination, but the population again took to the hills during the wars between the Greek cities and Carthage and the Punic wars. Under Roman rule the system of *latifundia* was introduced with extensive agriculture and

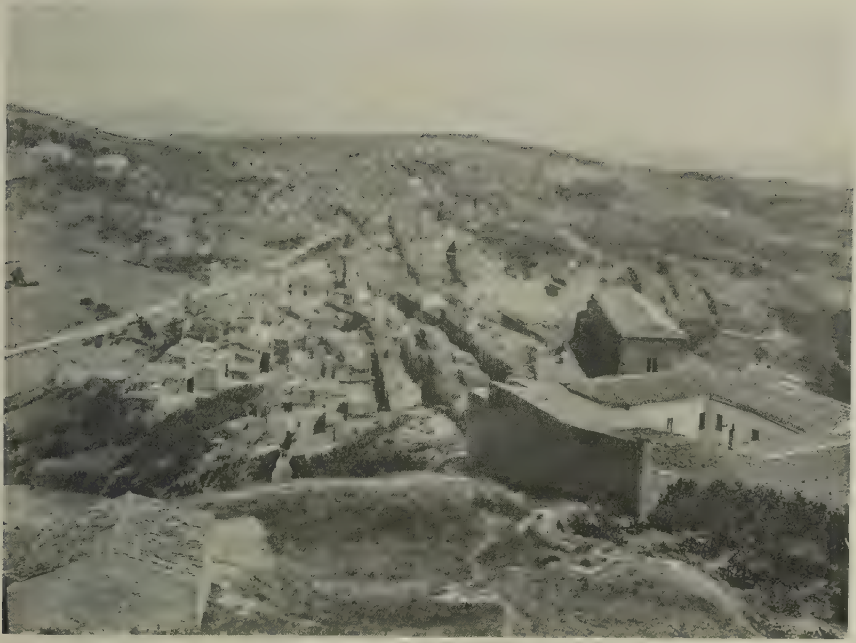

FIG. 1

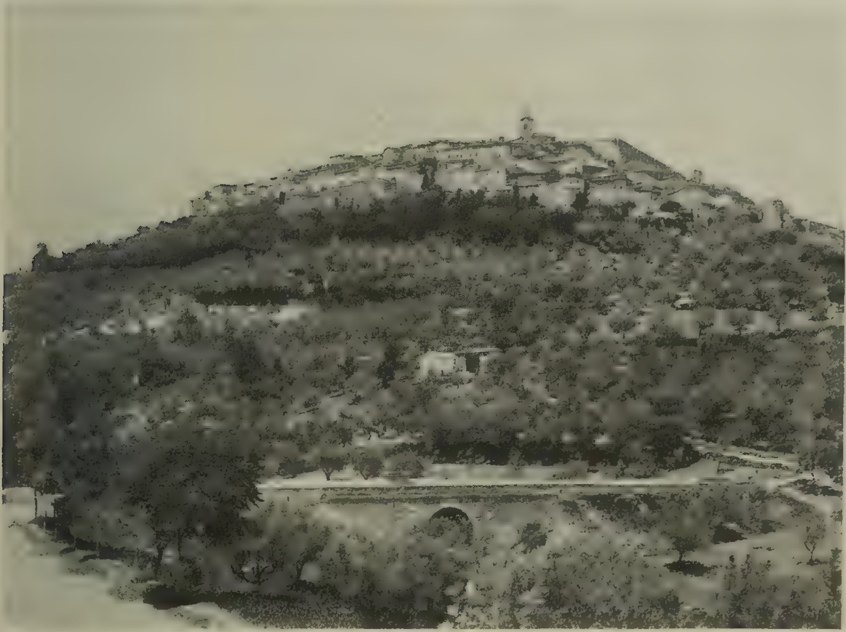

FIG. 2

FIG. 1—Calatafimi, a town of northwestern Sicily, 350 meters above sea level, on a rocky ridge 100–150 meters above the valley floor. Inhabitants in 1911 numbered 10,205. (Photograph by Brogi.)

FIG. 2—The town of Alatri, 60 kilometers east-southeast of Rome, 502 meters elevation, on the summit of a rocky hill planted with olive trees. Population in 1911, 4866. (Photograph by Alinari.)

concentrated settlement. Sicily became a wheat-producing land whose fields at Centuripa and Henna were of as much importance as the commerce of Syracuse.

The Arab conquest raised Sicily to a very high civilization. Irrigation and horticulture transformed the land. From the accounts of Edrisi and Ibn Jubeir we know that settlement took the form of scattered dwellings among the fields. Palermo, the chief city, bloomed in the middle of a huge garden. The total population is reckoned as 2,700,000. Under the later feudal system of the Normans civilization declined. Settlements were again concentrated, principally on the heights. The population of the sixteenth century is estimated at about one-third of that under the Arab régime. At the time of the Union of Italy Sicily found itself in a medieval stage of civilization.

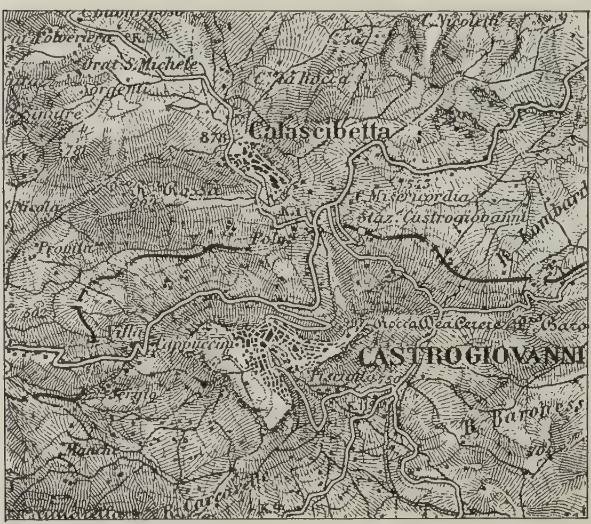

FIG. 3—Castrogiovanni, the successor of the ancient town of Henna in central Sicily. Situated on a plateau-shaped rock, the surface of which rises about 500 meters above the floor of the valley, where the Catania-Palermo railway runs. Inhabitants in 1911, 24,600. Calascibetta, north of the railway, occupies a similar topographical situation, 878 meters above sea level, with 7663 inhabitants in 1911. (Published by special permission after the map, on the scale of 1:100,000, of the Istituto Geografico Militare of Florence.)

INTERIOR SICILY

As has been said, settlement today still retains certain primitive characteristics. This is especially so in the interior and on the south coast. Subtracting a zone 5 kilometers wide along the east, north, and west coasts, we have left an area of 21,287 square kilometers with a population of 2,078,025, or 98 per square kilometer—not a high density as things go. Of the population only 4 to 11 per cent (1911) live in scattered villages of less than 100 inhabitants. Considerable areas between Palermo and Sciacca, for instance, have no dispersed settlement. Towns with a population approaching 20,000 have a majority of their inhabitants engaged in agriculture. So also do towns surpassing 20,000, such as Piazza-Armerina, Girgenti, Canicatti, Modica, Noto, Ragusa, Vittoria. Statistics show one-third engaged in agriculture; and, adding to that the large number who are described as "without profession," it is probable that two-thirds or more of the population are dependent on agriculture.

The accompanying graphs of hypsometric curve, number and density of population, show the tendency to location of settlements on the heights. Statistics, however, show an appreciable tendency of the population to descend to lower altitudes since 1861.

The house type is primitive. Characteristically it is a single-room square building, without chimney and with a door opening on the street. Excavations in the hillsides and caverns are still simpler abodes, and use of the latter was not infrequent at the beginning of this century. In 1901, for instance, in the town of Modica 938 caves were occupied as human dwellings. Now they are evacuated. Human establishments in the interior of Sicily and the life of the population taken as a whole give a striking picture of a primitive stage in our settlement series. The extreme development of *latifundia*, the curse of malaria, which in the lowlands has declined perceptibly only in the last decade, and brigandage are contributing causes. But one must not overlook the fact that the rough configuration renders difficult the supply of water for the irrigation needed by intensive exploitation. *Latifundia* occupy about 30 per cent of the whole island, the figure rising in an interior province, Caltanissetta, to 44 per cent. One-third of the area covered by cadastral survey is in the hands of 787 persons; one-sixth in the hands of 173 persons.

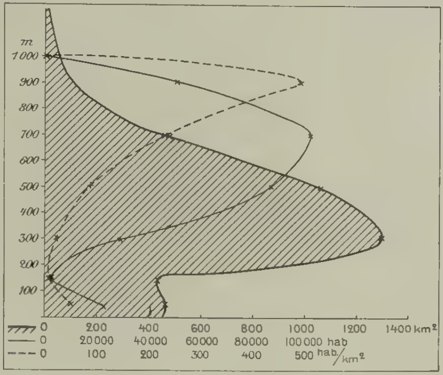

FIG. 4—Diagram of settlement of the Monte Erei district of southeastern Sicily, stretching from Terra Nova to include part of the Catanian plain. Shading shows the land area; the solid line, the number of inhabitants; the broken line, the density of population—all referred to heights above sea level. Among the towns in the district is Castrogiovanni (Fig. 3).

COAST SETTLEMENTS

The progress of settlement along the littoral is distinct from that of the interior. The series shows:

1. Small agglomerations in places with shelter for small vessels.
2. Concentration in places with good connections both with the immediate hinterland and over the water.
3. The great city with extensive commercial connections.

The Phoenicians or Carthaginians who first came to the shores of Sicily as colonists took possession of the capes and points, islands and peninsulas which offered protection from the wind. There they founded their trading posts. When the Greeks followed with greater intellectual and cultural resources they made use of the best harbors, creating important cities. Syracuse, for instance, was in its day one of the greatest world cities. The unique position of Sicily in the Mediterranean between east and west and as a bridge from the Apennine peninsula to Africa was now evidenced. The Greek cities had resources for their development quite different from those of the inland towns bound to their surrounding fields. During the Roman occupation the coast cities declined, to be revived by the Arabs. Relations with the north coast of Africa especially stimulated the southern cities. When it succumbed they also were lost.

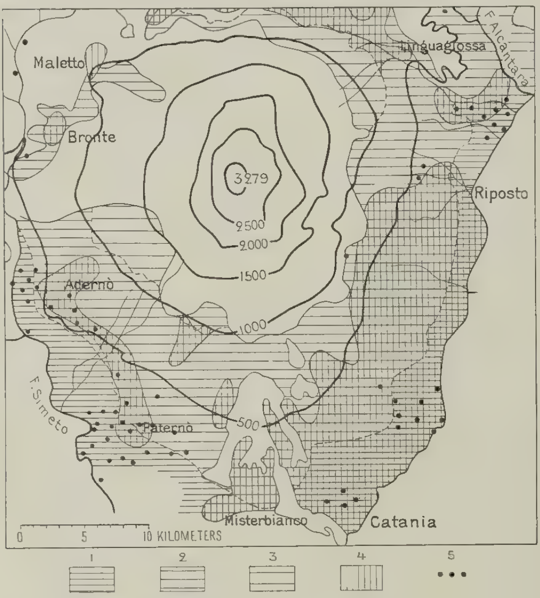

FIG. 5—Etna, cultivation and settlement map. Scale approximately, 1:6,000,000. 1, intensive horticulture, chiefly oranges and lemons, bounded by the upper limit of the olive; 2, less intensive cultivation, bounded by the upper limit of the vine; 3, more extensive cereal cultivation, bounded by the upper limit of rye; 4, thickly inhabited areas; 5, springs. Altitude curves, heavy solid lines, are drawn at intervals of 500 meters. Cultivated areas are after Paul Hupfer: Die Regionen am Ätna, *Wissenschaftliche Veröffentlichungen des Vereins für Erdkunde zu Leipzig*, Vol. 2, 1895, pp. 299–362. Springs are after the Carta idrografica d'Italia.

Unfavorable topography aided by sirocco and malaria still retards settlement on the south coast. The other three coasts show a higher stage of settlement than the interior. With an area of 2978 square kilometers they have (1911) a population of 1,094,200, or a density of about 365 per square kilometer. The dispersed population has a density of 50 to 100 per square kilometer against about 10 in the interior. The houses are better, urban development has been carried higher. The introduction of the orange was a specifically important fact for the coast zone; so later was the introduction of steamship lines for the export of fresh fruits. This type of fruit growing calls for intensive cultivation of the soil with irrigation. The greater part of the irrigated land in the island is in the coast zone.

VOLCANIC SETTLEMENT; ETNA

Etna, a young volcanic mountain, offers special conditions for human occupation. Settlement is determined by altitude above the sea, by the weathering of the lava, access to springs, and exposure. The uppermost zone below the crater is occupied only by the temporary settlement of herders; settlement becomes denser with increased weathering and number of springs. The lower southeastern slope is the most densely populated district of Sicily. Leaving out the population of Catania, which is largely urban, the density of the rural population here is 430 per square kilometer. This high figure is permitted by the fertility of the soil and the climate, which not only favors horticulture and aboriculture but lowers the cost of living; though the standard, it must be noted, is very low.

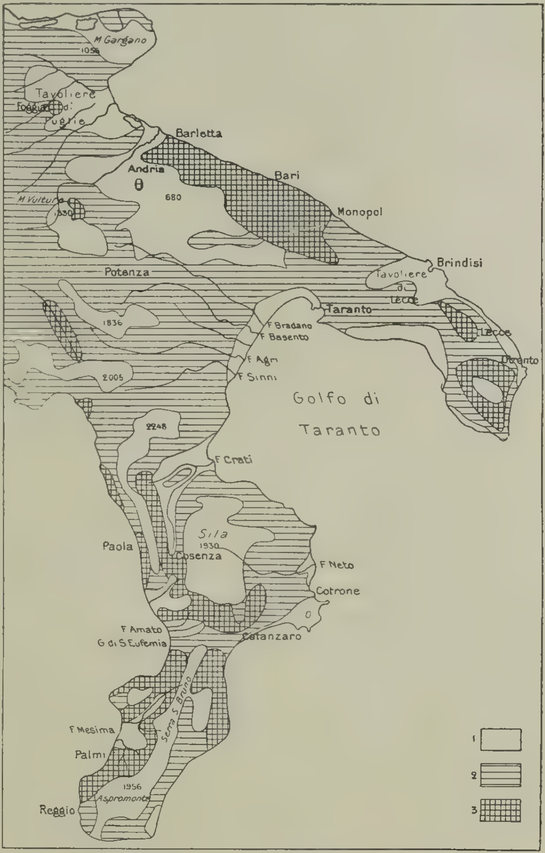

FIG. 6—Distribution of population in Calabria, Basilicata, and Apulia. 1, uninhabited or very sparsely populated; 2, comparatively sparsely populated; 3, densely populated. Scale 1:4,200,000.

SETTLEMENT IN CALABRIA

The distribution of population in the three southernmost provinces of Italy is shown in Figure 6. The areas of least density, less than 30 per square kilometer, are at the highest altitudes where rigors of climate discourage settlement, as in the crystalline massifs of Aspromonte, Silas, and the Serra S. Bruno of Calabria; or where extreme dissection of the surface gives an unfavorable topography, as in the "badlands" of the flysch of Basilicata or in the low river bottoms and the insalubrious coasts. High densities, over 100, are found in intermediate zones where intensive fruit and tree culture obtains, as well as in the northeast of Apulia, including Bari, and in Otranto.

From Scano's statistical reports[4] we learn that an increase of population in the lower zones of Calabria has been going on at the expense of the upper zones, a movement increased in late years by the coming of the railroad along the coast. The chief obstacles are malaria and in the valleys flood and erosion. As an illustration of settlement in Calabria we shall take the Crati valley. It is stated that Cosenza (ancient Consentia) was the site of the capital of the autochtonous Bruttiens. At the mouth of the valley was the famous Greek colony of Sybaris, and the great Roman road, the Via Popilia, passed by the valley.

Figure 6 shows how the population avoids the lower zone of the valley, where only a few scattered dwellings are to be found. On the western slopes the majority of the population lives in agglomerations in the upper zone at the contact between the unconsolidated sedimentaries and the schistose scarps where the oak forests cease and cultivation begins. The highest density is in the amphitheater about Cosenza, where it reaches about 200 per square kilometer excluding the big town. To the southwest on the schists, where springs occur, the population is more dispersed. Earthquakes are frequent, malaria is a serious handicap, and emigration is considerable.

BASILICATA

The discomforts from which Calabria suffers are even more accentuated in Basilicata. Figure 7 of that part of Basilicata fronting on the Gulf of Taranto shows the lack of habitations on the sandy coast and the low coastal plain, fertile but devastated by malaria, and in the broad valleys whose swampy bottoms are choked by débris from the enormous erosion and the frequency of landslides to which the flysch, covering a large part of the region, is especially liable. The forests, the former wealth of the country, are in large part in bad condition. The density of the agricultural population is only 40–50 per square kilometer, and there is a continual drain from emigration. Only 7 per cent of the population lives in dispersed settlements. The largest agglomeration, Matera, has 17,324 people, the smallest 746.

Settlements seek especially the patches of hard rock, *rocco tetto*, outcrops of schist in the soft Eocene clays. Almagià indicates respective densities of 167 and 7 per square kilometer on these two formations in the Basento region. The patchy distribution means a condition of great isolation. Different settlement districts have different manners, for instance. The wretched roads run along the crests separating the valleys. Though the topography is mature, the valleys as barriers are comparable with mountain chains.

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[4] Giulio Scano: Distribuzione, aumento e densità della popolazione italiana in rapporto all' altimetria dei centri abitati, *Riv. Geogr. Italiana*, Vol. 30, 1923, pp. 50–56, 158–168; Vol. 31, 1924, pp. 159–175.

Unlike the case in Calabria the railroad has not provoked settlement in the coastal lowlands of Basilicata: the railway stations remain isolated buildings in the deserted plain. The contrast with the ancient Greek coastal cities, such as Metapontum, is striking. That high stage of settlement, the highest for the region, was, however, an exotic flowering; without roots in native soil it bloomed and quickly died away. The present settlements belong to the first stage in the general series.

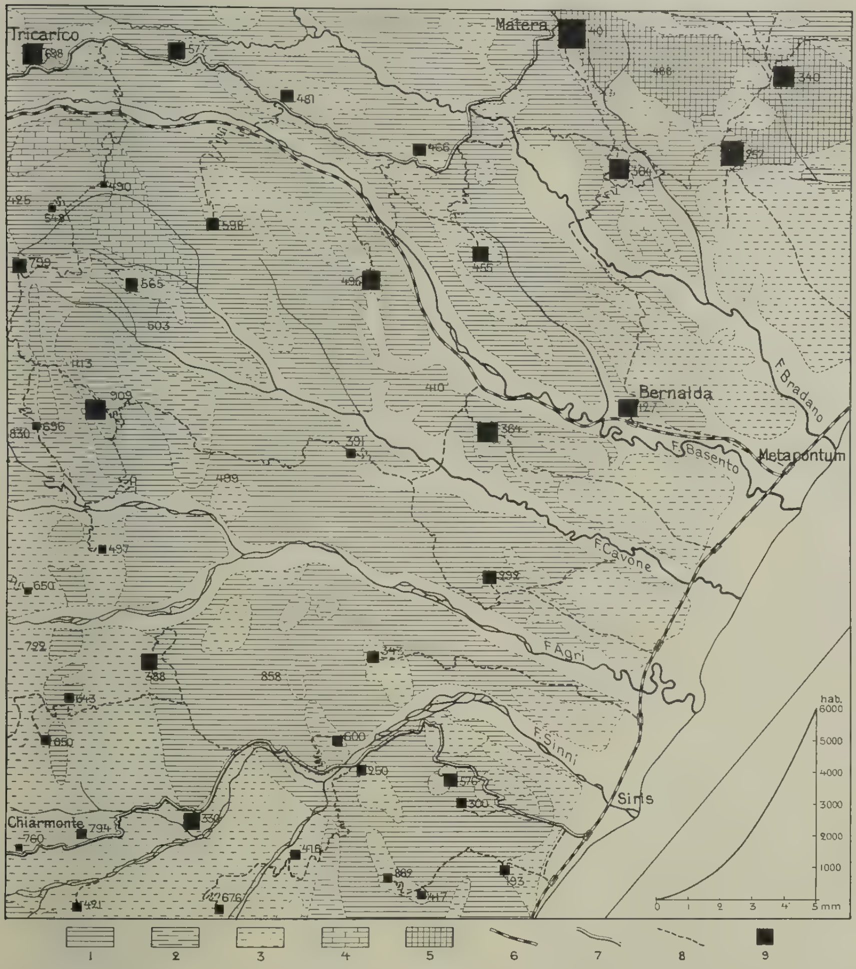

FIG. 7—The southeastern and central part of the province of Basilicata. Scale approximately 1:550-000. 1, impermeable clay, especially flysch; 2, compact sand and conglomerate, somewhat impermeable; 3, sand and gravel, not very permeable; 4, permeable lime and marl; 5, highly permeable compact limestone; 6, railway; 7, highroad; 8, secondary road; 9, agglomeration: population proportionate to the size of the square according to the scale in the lower right-hand corner of the map. Figures give heights in meters above sea level. In 1921 the population of the district was 163,400 persons. Of these about 92 per cent lived in the chief center of their respective communes. The number of agglomerations is 38.

APULIA

In Apulia the chief Greek and Roman settlements are still represented by living Italian towns, the latter because of their strategic locations, the former because of their sites as good natural ports. This is in contrast to Basilicata, where the flourishing Greek civilization entirely disappeared. During the Middle Ages Apulia played an important commercial rôle in relation to the eastern Mediterranean. However, the coast settlement of today cannot be considered to have reached an advanced stage in the settlement series. The Emperor Frederick II built strong castles and fortifications on the heights, which still remain as the "altstädte" of many towns of today.

In addition to the reasons already cited for hilltop concentration in subtropical Italy it must be noted that a large part of Apulia, the limestone plateau known as the Murgia, is the driest part of southern Italy. Settlement is extremely concentrated in large cities, which lie spider-like in well developed nets of roads. *Latifundia* occupy a great part of the country. Omitting the Bari region, the dispersed population is only 5 per cent of the whole. During the last decade the district of Foggia, for example, increased by 13,382 persons; but the town of Foggia itself gained 13,625; i. e. the population of the country has declined in favor of the town. In connection with the water problem we may note the building of an aqueduct, the Acquedotte Pugliese, not quite completed, which exceeds in magnitude the great Roman aqueducts and is indeed the longest in the world (2650 kilometers). It supplies 268 agglomerations with drinking water.

This concentration is not only due to dryness but to the limited amounts of cultivable land. In the fertile Bari region there is a comparatively large number of small farms, and the dispersed population is 2½ times that of the other parts of the territory. The agricultural population has a high density, over 200 per square kilometer, and is increasing with the parceling of the ground.

THE PLAINS OF CAMPANIA

Of the parts of the Apennine peninsula destined by nature to become population centers the plain of Campania is preëminent. It is unusually advantageously placed. The plain, largely formed of the fertile volcanic tufa, is surrounded by fault scarps and volcanoes and opens theaterwise to the sea. In the plain itself the chief river, the Volturno, with its low swampy banks, offers no inducement to settlement but rather the reverse. It divides the plain in two parts; and the more important southern section is again divided by the Regi Lagni.

The settlement of the littoral series early reached a high development. In the lee of an isolated trachyte rock east of the Phlegrean fields the Greeks founded Kyme in the eighth century before our era, later the starting point for Greek colonization around the Gulf of Naples. Littoral settlement reached its peak during the Roman Empire with Puteoli and Naples, the naval base Portus Misenus, and the resort Baiae. In the interior, Capua was founded early. Its location, low on the plain, was something very rare in the Italian peninsula. Only the wealth of Campania permitted the city to survive various vicissitudes.

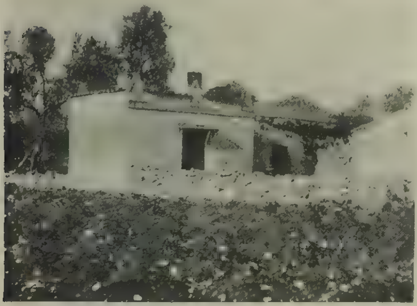

FIG. 8

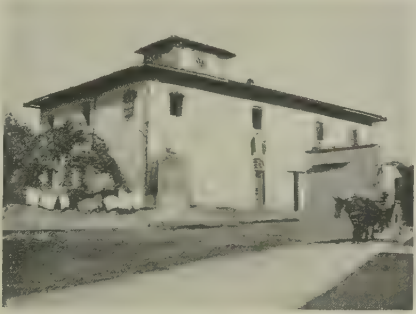

FIG. 9

FIG. 8—Isolated farm in the Bari district. The house is a simple parallelepiped with white walls, a small number of windows, and flat roof. Limestone fragments gathered from the plowed land have been piled up to form a wall around it. Olive trees behind the house; on the wall in front the single grapevine.

FIG. 9—Tuscan peasant farmhouse.

The extent of the peopling of the plain in antiquity is uncertain. The point to be emphasized is the hostility of the watercourses to settlement.

PRESENT SETTLEMENT ON THE PLAIN

The climate borders on the subtropical, and summer rainfall is still insignificant. The intensity of the garden cultivation and the huge harvests derived therefrom are well known. Under the grapevines which hang in garlands, like heavy draperies between the tall trees, grow corn and all vegetables. The verdure is an expression of fertility quite overwhelming to a northerner. This apparently inexhaustible bounty of thousands of years is the prime reason why the Campania is the most densely populated agricultural region in Europe. Settlement is extremely concentrated. Between towns one finds only an occasional isolated house and here and there a single large conical hut of poles, twigs, and straw.

As is seen from the map, settlement is divided into two regions separated by the area of less dense population around Regi Lagni.

The total population of the towns of the southern part was 266,000 in 1911. The largest town, Aversa, has 22,545; the smallest independent town, Casaluce, has 1399. A considerable proportion of the population outside of the independent towns live in smaller agglomerations very like them in character. The northern region had 111,000 people in the towns in 1911; Caserta, the largest town, had 19,808; and the smallest, S. Marco Evangelista, 1547.

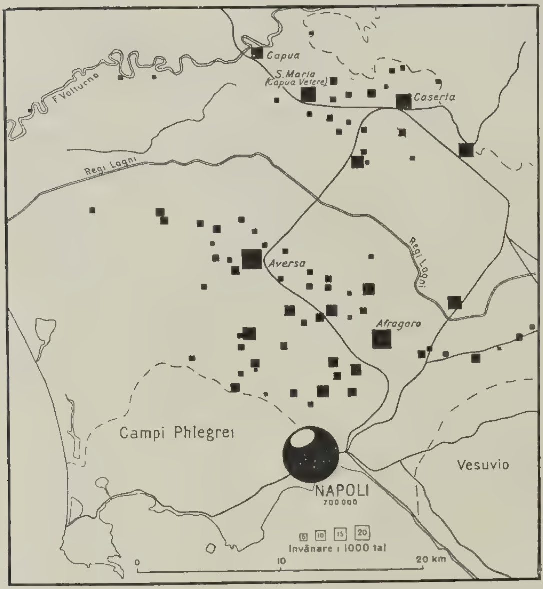

FIG. 10—Settlement on the Campanian plain between Naples and Capua. The population of the agglomerations (1911) is proportionate to the size of the squares according to the scale shown.

I lack material for exact computation of the density of the agricultural population. In the following I have estimated 80 or 90 per cent of the total population as dependent on agriculture, a figure probably not too high. Evidently such large towns as Aversa cannot live on agricultural enterprise conducted only within the limits of the commune. This is more nearly possible for such places as Melito di Napoli, Parete, Trentola, Lusciano, Frattaminore, and Crispano. The average density for these is 640 (80 per cent) or 725 (90 per cent). For the southern region as a whole I estimate densities of 756 or 850: for the northern region, 790 and 895. The highest figures are probably too high, but it can be safely said that the present density of population on the densely settled regions of the Campania plain is between 700 and 800 per square kilometer. Not only the fertility of the soil and the climate are responsible: the standard of living of the population is extremely low. The region is admittedly overpopulated; the highest density compatible with the good of the population is far exceeded.

COMPARISONS OF POPULATION DENSITY IN SUBTROPICAL ITALY

The density of population dependent on agriculture for the regions of subtropical Italy studied is summarized thus: Basilicata, about 40; interior Sicily, 90; Bari district, 215–240; Crati valley, 200; southeastern Etna, 430; Campania plain, 700–800 per square kilometer.

Intermediate degrees are found; but 40–90, 200–240, 700–800 are indicative of the various stages of agriculture and stages in the settlement series within the region studied. It may be worth while to note that the lowest density here indicated is only a little lower than the highest density of Scandinavia. Density is a function not only of fertility but also of climatic influence on dwellings, clothing, food, etc., and of standards of living, all of which are relatively much higher in Scandinavia.

The development of settlement in the general series in southern Italy and especially Sicily in the course of history shows how, in periods with high civilization and peaceful conditions and good government, human settlement exhibits a tendency to break away from the agglomerations situated on heights and hills which form the primitive stage and to spread over the lower-lying districts. During periods of public and private wars, of lower civilization, and of inferior government human settlement exhibits a tendency to return to the primitive state. We shall now proceed to see how these stages in the general series are repeated in other parts of Italy and how their regular succession contributes to make clearer the causes why the city of Rome so early attained greatness.

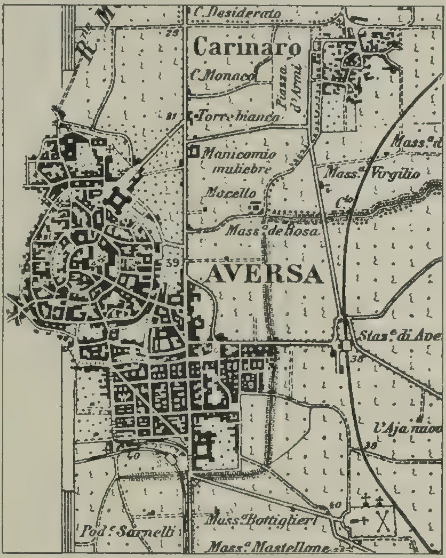

FIG. 11—The city of Aversa, 14 kilometers north-northwest of Naples, in the southern part of the Campanian plain. Scale 1:25,000. Population in 1911, 22,545. (Published by special permission after the original map, on the scale of 1:25,000, of the Istituto Geografico Militare of Florence.)

THE RISE OF ROME AND HER GREATNESS[5]

Alba Longa, in the Alban mountains, was the progenitor of Rome. Historical records likewise show the mountains and hills around the Roman Campagna settled very early by the important cities of Tibur (Tivoli), Praeneste (Palestrina), Tusculum, Aricia, etc., the Etruscan cities of Caere, Veii, etc. From these descent was made for the pasturing of the flocks and herds. Movement down to the plain was given direction and made easier by the many small streams occupying ravines in the easily eroded soil and affording excellent strongholds. In time the herds became permanently established on the plain, and the small groups of huts grew to towns. Their appearance and character are established by archeological finds.

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[5] See my study "Rom-Capua" (*Ymer*, Vol. 45, 1925, pp. 440–456) for greater detail and bibliographical references.

A chief geographical reason for Rome's early greatness I believe to lie in her relation to the series of developments described in the foregoing pages as the general series. Rome, owing to her central position on the plain, surrounded by older centers of settlement on the circumjacent hills, was the first to draw advantage from the great material benefit which consists in the attainment by settlement of its second phase of development, namely the conquest of the low country. In other words, Rome reaped the benefit of the important process of development which consists in the moving down of human settlements from the heights to the lowlands. It was not alone her own strength nor her commercially strategic position on the Tiber, but it was all the power which had been accumulated in the mountain towns and for the first time was called forth, in the settlement and cultivation of Campagna, and which, so to speak, radiated topographically to the seven hills.

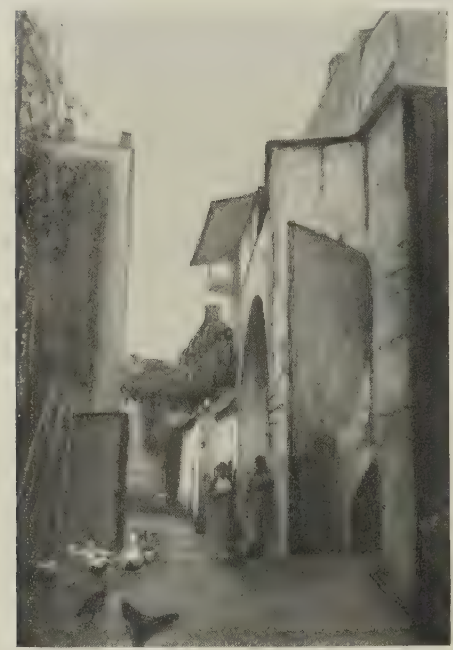

FIG. 12—Interior of a house in Afragola, 9 kilometers north-northeast of Naples, southern part of the Campanian plain.

Development in Other Parts of Italy

During the long period of peace in Romanized Italy when no foreign armies trod the soil a considerable increase took place in the dispersed population on the lowlands. Growing prosperity and replacement of communal by private ownership created growing interest in agriculture. Especially after Sulla's dictatorship there began a feverish development which in the course of a century entirely revolutionized the old peasant civilization. Agriculture, which had been based on grain-growing, yielded to horticulture. Varro describes Italy as a kingdom of gardens. The more intensive cultivation demanded attention to irrigation. As now, it encouraged scattered settlements.

The tendency towards dispersion did not, however, reach its full development; nor did it last long. It constituted the best, the most powerful phase of the Roman state. The civilization which fostered the third stage of settlement was highly susceptible to changing influences since it depended so largely on careful drainage and irrigation systems. The later swallowing up of the small holdings by the *latifundia*, the disappearance of the small peasant proprietor, and the resultant extensive culture, stock raising being most profitable, caused the collapse of the irrigation system. Grainfields became pasture, gardening declined, marshes crept in, and malaria spread. The population was again forced to the highlands to the old locations, and the second and third stages in the general settlement series became only a passing incident.

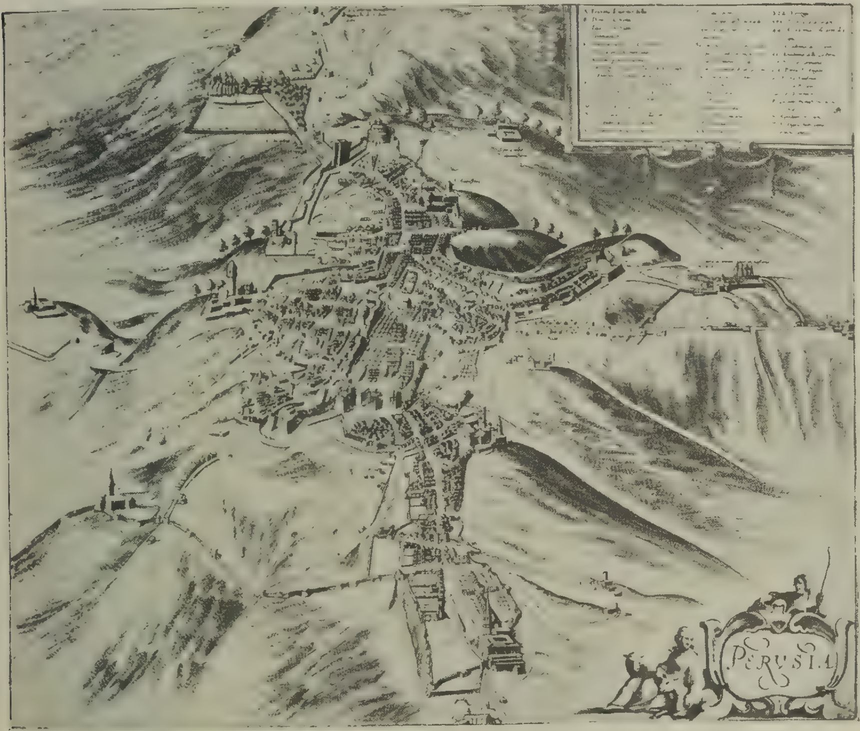

FIG. 13—Perugia. (From "Theatrum celebriorum urbium Italiae, aliarumque in insulis Maris Mediterranei," Joannes Jansonnius, Amsterdam, 1652?).

HILLTOP TOWNS IN ITALY OF TODAY

Not only in southern Italy is population today concentrated on the heights in agglomerations largely made up of agricultural workers. Every traveler in Italy is familiar with these towns on the hilltops, terraces, and highlands (Fig. 2). All the small towns are much alike with their small gray stone houses fronting the steep crooked streets along which the peasants go to their fields in the morning and return in the evening.

Admirable as far as strategic location goes were the Etruscan towns. Many of their successors, Perugia, Orvieto, Volterra, occupy the crests of hills; Orvieto on its tufa cliff possesses such an extraordinarily fine location that it needed only a little construction to be practically impregnable to older military skill. Perugia spreads out on the broad ridges and corresponds in position with Siena. All the towns of today have their railroad stations at the foot of the hill.

In the Adriatic sub-Apennines settlement is confined to the highlands between the broad valleys with their overflowing rivers. The roads are typical watershed roads, *strade di spartiacque*. The region reminds one of Basilicata except that the population is much denser, averaging 100 per square kilometer; and the railroad along the Adriatic has stimulated a row of towns. As in Calabria this settlement, however, has been to a great extent independent of the sea.

In that part of Monferrat which lies between Asti Chivasso and Casale (east of Turin) the settlement is one of the most extreme highland type I have observed in Italy. The limestone mountain sides are given over to vineyards; the valleys are cultivated but are empty of habitation save for an occasional hut. The population is concentrated in fairly numerous towns on the ridge tops—generally a single or double row of houses strung along the road.

Along with this first stage settlement appears in some districts here a more dispersed settlement on the lowlands, representative of the second and third stages. The district of Florence and the Roman Campagna are cases in point.[6]

Numerous too are the towns in the mountains of central Italy which are now in process of abandonment, because their population is moving down to lower parts of the district. The development of human settlement is making rapid progress in the Italy of the present day; and here, as in so many other places, may now be applied the proverb cited by Vidal de la Blache from the Pyrenees, "baixar sempre, mouton no," that is to say, "always move downwards, never up again."

The Development of Towns in Germany

In passing from Italy to countries north of the Alps, it is necessary to touch, at least lightly, on the still discussed and far from solved problem of the rise of cities in Central Europe. In Germany, as in the rest of the Teutonic world in general, there is quite another difference and contrast between urban and rural settlement than that which prevails in Italy. Without exaggeration it may be said that no period of equal significance as that during which the towns came into being has been known in the history of settlement in Germany until the introduction of industrialism in our own times and the development of the modern great cities.

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[6] See the note on Ashby's "The Roman Campagna in Classical Times" in this number of the *Geogr. Rev.*

THE FIRST SEDENTARY SETTLEMENT

To the earliest permanent settlement the forest was an enemy in a very high degree. Hence the most suitable regions for settlement, and indeed those which were actually first taken into possession, in Central Europe lay chiefly on the steppe, where it borders on the forest.[7] The archeological excavations of later years in Germany indicate that sedentary settlement even in the Neolithic Age was gathered into groups rather than scattered. And such, indeed, it probably remained for a long period. In comparison with Italy, however, it must have struck observers as very primitive; and its lack of real towns led Tacitus and Caesar to describe it as scattered.

In those parts of modern Germany within the limits of the Roman Empire the Romans founded the first towns, some of which grew to be important, as Trier. With the decline of the Western Roman Empire came the decline of the Roman towns in Germany as in Italy. Sombart[8] is of the opinion that in Germany they entirely disappeared. In opposition Dopsch[9] maintains that Roman traditions persisted and that the towns though they lost in population and prosperity yet remained a foundation for later city growth.

As the Franconian Kingdom developed and Christianity was introduced agriculture also developed and land was inproved, so that about the eleventh century the landscape was differentiated into forest land and settled land, divisions which still persist in the main. The breaking up of the Carolingian Kingdom by the resulting lack of political and social unity delayed the development of settlement. Progress was chiefly accomplished by the large estates, especially those of the Church. The work of the Cistercian Order of Benedictines in regard to agriculture is especially worthy of note.[10] Reclamation of new land continued when the farmers were allowed to improve the common land of the village. Thereafter in the twelfth century agriculture became intensified. The advantages of multiple plowing, manuring, terracing of vineyards, and growing of forage plants began to be appreciated. At the same time vine and olive culture was revived in Italy, and in England new land was reclaimed and the three-crop rotation system introduced. Increased diking made possible the improvement of swampy lands.

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[7] Robert Gradmann: Über die Bedeutung postglaziale Klimaänderungen für die Siedelungsgeographie, *Zeitschr. Deutsch. Geol. Gesell.*, Vol. 62, 1910, pp. 117–122. See, too, Hoops: Waldbäume und Kulturpflanzen.

[8] Werner Sombart: Der moderne Kapitalismus, 4 vols., Leipzig, 1919; reference in Vol. 1.

[9] Alfons Dopsch: Wirtschaftliche und soziale Grundlagen der europäischen Kulturentwicklung aus der Zeit von Cäsar bis auf Karl den Grossen, 2 vols., Vienna, 1918–20.

[10] T. von der Goltz: Geschichte der deutschen Landtwirtschaft, Stuttgart, 1902.

The household economy of the past changed to a more highly developed money economy. Trade and communications increased. In the eleventh and twelfth centuries Germany added about 150 new towns:[11] in the thirteenth century at least 800 were founded. Kurt Hassert[12] says that in 400 years 2500 towns appeared.

Many other factors contributed to bring about this rapid development of the towns as a new form of settlement. The Crusades played a part because they acquainted other countries with conditions round the Mediterranean where towns were primary forms of settlement. Many old marketing centers naturally grew into larger places and became towns.[13] Villages also would seem to have been able to follow the same course of development. An important place amongst the towns of Germany is also taken by those which were founded within the area of German colonization in Slavonic territory.

The distinguishing feature between village and town is the presence in the latter of a greater number of food consumers who are not food producers. The creation of a town therefore implies a surplus of agricultural products. This medieval growth of towns exhibits very nicely the relationship between cultural-economic conditions and settlement, i. e. shows settlement as a result of the cultural level, which is one of the leading ideas of this paper.

According to the origin and functions of these medieval towns their present successors can be arranged in groups.[14] The distinctive differences appear especially in the network of streets, which is the conservative element in the structure of towns.

These medieval towns increasing rapidly in number and size are characteristic of a higher and later stage of development in the general settlement series. Culture, power, public interest located themselves there and the rural communities were left to live their own lives. Economic policy as a whole was very one-sidedly urban in character. A migration to the towns took place comparable with what took place in Italy in the Roman Empire and what is going on at an increasing rate in all civilized countries today.

Several scholars have emphasized the fact that the town walls which were built in the fourteenth century were as a rule satisfactory up to the mid-nineteenth century. Then urban population increased so much that the 500-year-old boundaries were transcended. It is of course true that the fourteenth-century walls in many cases included cultivated areas which could be used for building space, but on the other hand the medieval towns suffered from crowding, as we know by plans and house types.

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[11] H. B. Knüll: Historische Geographie Deutschlands, Breslau, 1903, pp. 143–163.

[12] Kurt Hassert: Die Stadte: Aus Natur und Geisterwelt, Leipzig, 1907.

[13] On this so-called "Mark theory" see G. von Below: Zur Geschichte der deutschen Stadtverfassung, *Jahrbucher für Nationalökonomie und Statistik*, Vol. 105, 1915, pp. 651–662.

[14] Walter Geisler: Beiträge zur Stadtgeographie, *Zeitschr. Gesell. für Erdkunde zu* Berlin, 1920, pp. 274–296.

Some Examples of Settlement in Denmark[15]

Denmark offers a fertile field for the study of settlement. Situated on the outer edge of the last ice sheet that covered the Scandinavian peninsula, this well defined glacial drift region has a marked topographic uniformity. The predominance of agriculture and the attention that has been paid in the country to the geography of civilization are other helpful factors in analysis of the problem.

The traveler passing from the rugged regions with their beech woods and coppices and isolated farmsteads to the open, gently rolling plain will see before him a picture of fertility and prosperity. Fine crops grow on the well-kept fields, well-fed cattle graze on the pasture lands, and numerous motor cars and bicycles roll along the excellent roads. Around most of the railway stations well-built little communities have sprung up. The small farmhouses with their four wings built in a square around an enclosed yard lie either scattered over the country or gathered together in small groups. These are the remains of the larger villages reduced by the agrarian redistribution of a hundred years ago. Both farmsteads and villages exhibit the solid work and the secure prosperity created by the rich soil and high cultivation of Denmark. Nearly everything looks different here from what we see in southern Italy; but nevertheless we shall find that in the main features of its development the settlement shows resemblances thereto.

THE FIRST PERMANENT SETTLEMENT

When agriculture and stock raising were introduced during the New Stone Age the people moved inland from their kitchen midden settlements on the coast and lake shores. Studies by S. Müller and V. La Cour[16] on the distribution of burial mounds from the Stone Age in areas in both northern and southern Jutland as well as in Zeeland show that early settlement avoided the lower lands of heavy clay soil, the steeper hills, the valleys, and the sandy heaths which last are even now largely uninhabited, choosing in preference the more gently sloping hills with light, easily cultivated soil. In a region studied south of Limfjord the burial mounds lie along well defined lines rightly interpreted as roads. These lead to the middle of the peninsula where, west of Viborg, was an important center. Many churches were later built along these Stone Age roads, and in many places modern highways follow them. The settlement sequence reminds us of Italy. The clay plains, difficult of drainage, more densely wooded, were more intractable to the cultivation of the time than the lighter sandy soils at higher altitudes.

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[15] I have treated the settlement of Zeeland in an article in Swedish, "Själlands landsbygd" (*Ymer*, Vol. 43, 1923, pp. 81–126), and also have published a more comprehensive survey of the development of settlement in Denmark and Norway in an article "Om lagbundenhet i bebyggelsens utveckling i Italien, Danmark och Norge" (*Ymer*, Vol. 47, 1927, pp. 1–48, 139–172). These articles cite all the literature taken into account; with one or two exceptions the books and papers mentioned are published exclusively in one or other of the Scandinavian languages, Swedish, Danish, and Norwegian.

[16] Sjællands ældste Bygder. Copenhagen, 1927.

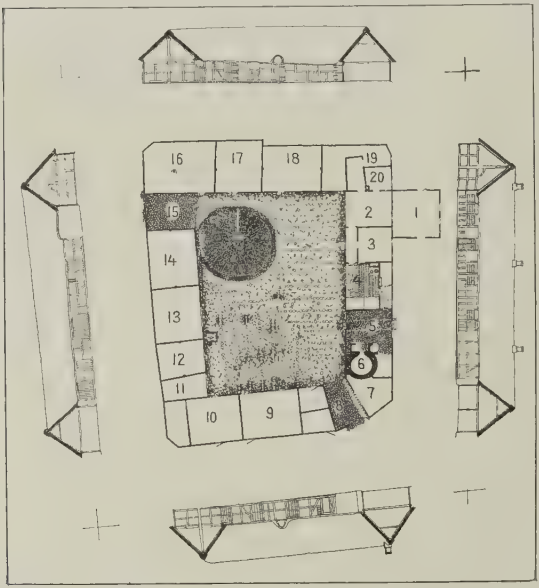

Fig. 14—Plan of a Danish quadrangular farm, Lundager, County of Odense, Fünen. 1 and 2, main rooms; 3, small room; 4, kitchen; 5, brewhouse; 6, bakery; 7, peat store; 8, gate; 9, stable; 10, cattle shed; 11, cart shed; 12, byre; 13 and 17, threshing floors; 14, rye granary; 15, main entrance; 16, barley granary; 18, granary; 19, chamber; 20, guest room. (After the original in the Danish Folk Museum, Copenhagen.)

During the Bronze Age settlement begins to move down to the lower clayey plain. During the Iron Age this movement continued. V. La Cour, in his recently published work, adduces weighty reasons for believing that fixed settlement even during the later Stone Age was concentrated in groups. Possibly it was only later, and in connection with the continued expansion of cultivated areas over the lower regions, that a scattered mode of settlement made its appearance.

Villages and Dispersed Farms in Denmark

It is still uncertain when the villages that were firmly organized on community of economic and social interests arose in Denmark. The villages appear in three forms, the closed or round village, with the farmsteads enclosing a square or circle about an open space; the long village, with farmsteads in two rows along a road; and the irregular village. In my treatise on Zeeland I showed how the villages are distributed in the open, gently rolling country, while dispersed farms on manorial estates and small hamlets are found in the wooded and more rugged country. In spite of the fact that there seems to be no difficulty from the standpoint of physical geography in changing the boundaries between these two regions, La Cour's work has confirmed my view that the great difference between them from the standpoint of cultural geography has existed for a very long time, even from the New Stone Age.

Growth of Towns in Denmark

It is uncertain how and when the first towns in Denmark came into being. For the most part it was not until the remarkable growth of towns in Germany previously discussed spread to the southern Baltic regions in the late twelfth and early thirteenth centuries that Danish towns arose. These were usually founded at the command of a king or overlord for encouragement of trade and promotion of revenue. Suddenly, as if by magic, a host of towns sprang up in the thirteenth century, many along the coast. During the kitchen-midden period the coast, the strands of lakes, and watercourses had been the chief places of settlement; but with the coming of agriculture they had been more abandoned. Now the littoral series began to advance. At a very early time Hedeby-Schleswig was a considerable commercial center, and many of Denmark's most important towns, such as Ribe, Viborg, Aarhus, Randers, Horsens, Odense, Roskilde, were founded in the eleventh century. It is striking how many of these towns are situated at the farthest heads of the bays.

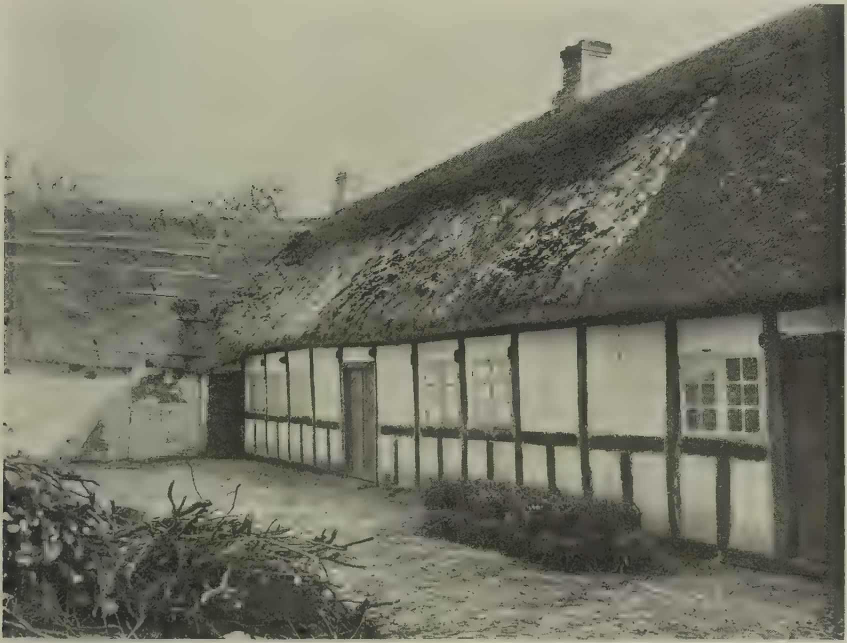

Fig. 15—Interior of the farmhouse at Lundager, County of Odense, Fünen. (After the original in the Danish Folk Museum, Cophengaen.)

The towns founded by the Valdemar kings—twelfth to fourteenth centuries—were usually built around church and market place. We can safely say of most of the older towns of Denmark that the size attained at the year 1500 did not appreciably change during the next two or three centuries.

Modern Settlement in Rural Districts

The settlement defined by the rise of towns and colonization of villages persisted until the agrarian redistribution beginning at the close of the eighteenth century. Then concentration in closed villages and the strip system of landownership were recognized as inefficient and incompatible with the rational use of land. The redistribution that followed was an unheard-of attack on a centuries-old tradition and carried with it revolutionary change in settlement of the rural districts.

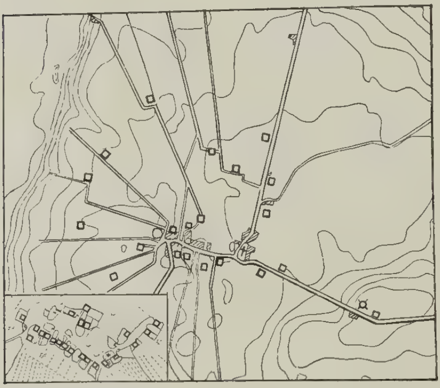

Fig. 16—Village of Faardrup, County of Sorö, Seeland. Scale approximately 1:35,000. The inset in the left-hand corner shows the village in 1770, before the rearrangement of holdings. The main map shows the present stage after this rearrangement, with the farms moved out to the edges of the hill on which the village stands.

Concerning relative populations it is to be noted that until 1877 the population of the rural areas was larger than the urban ones; but the situation has rapidly been reversed. Since the mid-century the railroads have been a deciding factor in the growth of urban and semi-urban population. Careful calculation of density of agricultural population per unit of cultivated land in eight chief farming areas of Zeeland shows that it varies between the close limits of 55 to 64 per square kilometer. An average of 60 per square kilometer of tilled land is therefore a measure of what the rural districts of Zeeland can support under existing economic and social conditions. This density has not changed from 1860. The best agricultural land of Zeeland is therefore saturated. The conditions are so stabilized that no change to speak of can take place except through some revolutionary occurrence.

The evolution of settlement which through the course of ages has led up to the present situation can be summarized in the following chronologically arranged stages:

1. Fixed dwellings gathered into groups and located mainly on the higher parts of the rolling plains of easily worked soil.
2. A movement down to the clayey areas, which is still going on.
3. The rise of the towns.

4. The government decree as to the breaking up of the enclosed villages by means of emigration to scattered dwellings.
5. The development of Copenhagen into a great city.

COPENHAGEN AS A METROPOLIS

Figure 17 shows the territorial development of Copenhagan from the little shore village with a mooring place for vessels, which is mentioned in history for the first time in 1043, down to 1921, when the urban area included in the map contained 700,610 inhabitants. This development has been greatly affected by the fortifications around the town. The older girdle of fortifications from the close of the thirteenth century was replaced in the middle of the seventeenth century by a large new girdle. The increased population of about 45,000 souls between 1801 and 1852 found accommodation within the walls by increasing the heights of the houses from 18 to 21 ells. Pressure of increasing population continued, however; and in the mid-nineteenth century the fortifications were razed, and the ramparts and moats were partly transformed into parks.

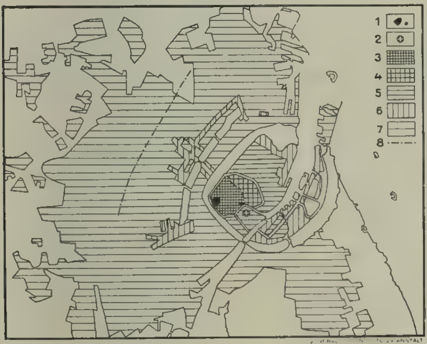

FIG. 17

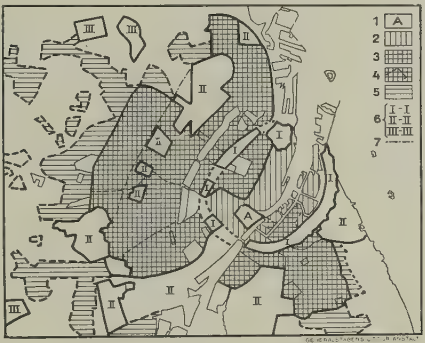

FIG. 18

FIG. 17—The evolution of Copenhagen proper. Scale approximately 1:180,000. 1, approximate site of first village and harbor; 2, Bishop Absalon's castle (1167); 3, the first town, probably as in Bishop Absalon's time; 4, urban area within the fortifications at the close of the thirteenth century; 5, urban area about 1700, within Christian IV's fortifications in the seventeenth century; 6, urban area about 1854; 7, urban area of Copenhagen proper about 1921; 8, the boundary line in the year 1660. (Compiled from D. Bruun; Danmark, Vol. 2, Copenhagen, 1919, and from maps of Copenhagen and its environs in the Uppsala University library, especially T. Brandh's map of 1854).

FIG. 18—Map of Copenhagen proper. Scale approximately 1:180,000. 1, Slottsholmen ("The Castle Island"), population density 1100 per square kilometer; 2, "city" area, density 24,900 per square kilometer, with the naval and commercial harbor on the east; 3, area of close settlement, density 40,000–82,000 per square kilometer; 4, part of Frederiksberg, within 3, that has density of only 25,000 per square kilometer; 5, area now being built up, density varying about 25,000 per square kilometer; 6, three open belts of parks, hospitals, cemeteries, station yards, aerodromes, etc. (Based on the map on the scale of 1:20,000 which accompanies "Statistisk Aarbog for København, 1924," and the population statistics in that annual.)

Figure 18 shows the morphological divisions of the city of Copenhagen as it finds expression in different degrees of density of population. The accordance between this map and the preceding one is manifest. Slottsholmen, where Bishop Absalon's stronghold was situated, is still occupied by a palace (now the Houses of Parliament) and other large public buildings, which causes the density to be the lowest. Adjacent parts of the oldest and the older parts of the town now stand out as a "city" core. The density of population in this core was 51,000 per square kilometer in 1880 and has since then fallen continuously, being 37,700 in 1901, and 24,900 in 1924. In the great residential area the density varies between 44,000 and 82,000 per square kilometer, according to the height of the houses and the size of the dwellings, a matter which in its turn is connected with the economic circumstances of the inhabitants. In one special area (in Fig. 18, No. 4, indicated by a dotted line) the density is only 25,000 per square kilometer, because it is composed for the most part of the one-family houses of the well-to-do class.

Every great period in the development of the town since its emancipation through the razing of the seventeenth century fortifications forms, as it were, a new zone, consisting of a more or less continuous area of settlement surrounded on the circumference by the space-exacting establishments with open spaces which the humanitarian and hygienic ideas of the time demand—parks, hospitals, almshouses, and other municipal institutions, and establishments such as gas works, cemeteries, and the like. Three concentric open zones now exist in the city.

Of no small interest for our conception of the character of the modern metropolis of Copenhagen is the make-up of its population with regard to origin. Of the 700,610 inhabitants of the town in 1921, 323,311 had immigrated there; and of these 152,829 (22 per cent) had been born in the Danish countryside, 108,574 (15 per cent) in the provincial towns, and 42,673 (6 per cent) abroad. According to the census of 1921 the number of inhabitants in the Danish countryside was 1,760,000 and in the Danish provincial towns 643,600 (if the districts in South Jutland obtained after the World War are deducted). Thus it is a great tribute which the country as a whole has paid to its capital.

Settlement in Norway

The interior of Norway presents a glacially eroded alpine region, with well marked mountain settlement series, while the fiord-broken coast with skerries shows a distinctive development of the littoral series.

In Norway the roads are long and steep, the fiords and valleys deep, and the population scanty; the settled districts are far apart and do not greatly change the face of nature. The small gray houses

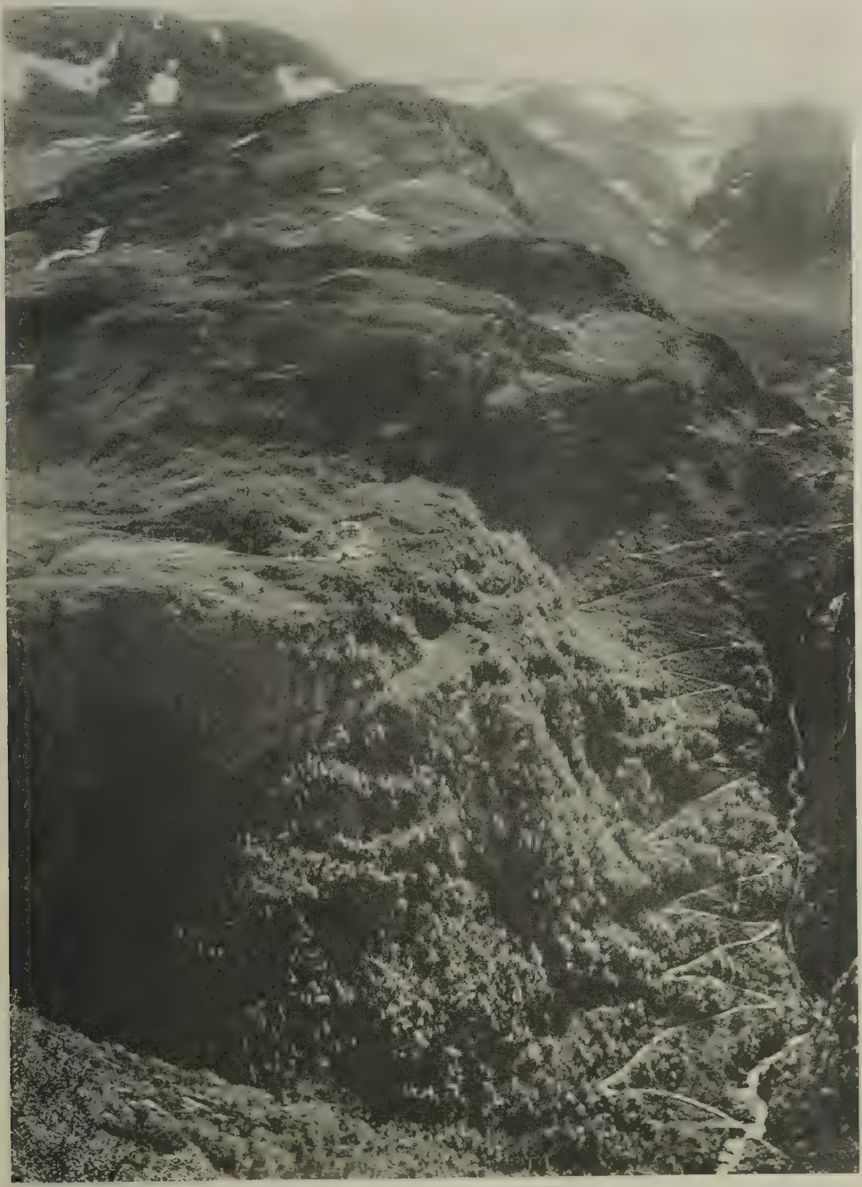

FIG. 19—Steep upper end of Flamsdal towards the Hardangar fells. The bottom of the valley, at the foot of the serpentine road, lies about 450 meters above sea level. Here permanent agricultural settlement ends. At the extreme right, at the summit of the road, can be seen Myrdal station (867 meters above sea level) on the Bergen-Oslo railway; tunnels on both sides of it. To the left of the picture a tourist hotel. (Photograph by Wilse.)

of the fishing population cling limpet-like to the naked coast; the isolated farmsteads press close against the mountain sides, their *saeters* high up above them; the streets of the towns feel their way cautiously along the shores and over the rocky hillocks as they can.

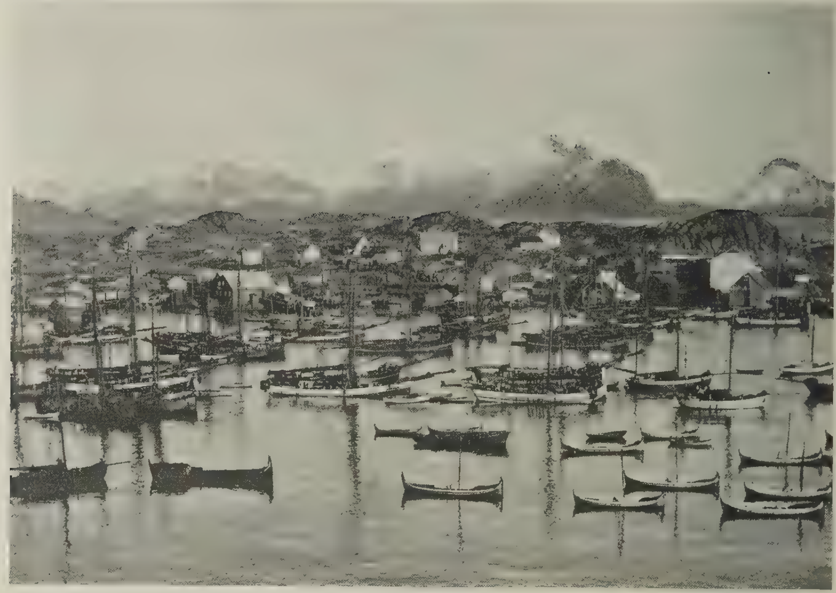

FIG. 20

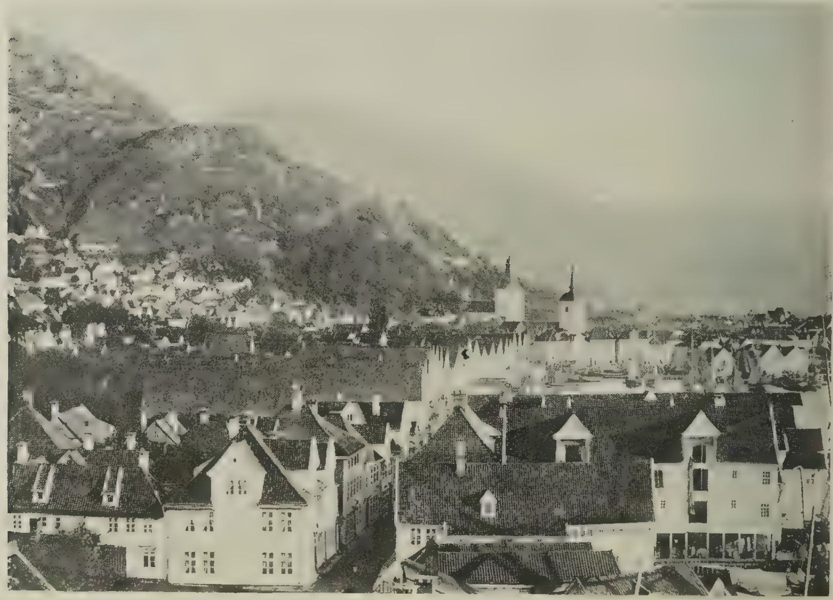

FIG. 21

FIG. 20—Balstad in Lofoten. A typical fishing station situated on the low coastal platform, from which the fells rise steeply to a height of 300–500 meters. The larger houses back from the shore belong to the settled population. On the shore itself warehouses and cottages for use during the cod-fishery, January–April. (Photograph by Wilse.)

FIG. 21—Bergen: the oldest part of the town at the end of the nineteenth century. Tyskebryggen (the German quay) in the middle, with long houses, gables facing the harbor. The wooden buildings on the quay have been replaced by stone and modern equipment. (Photograph by Selmer).

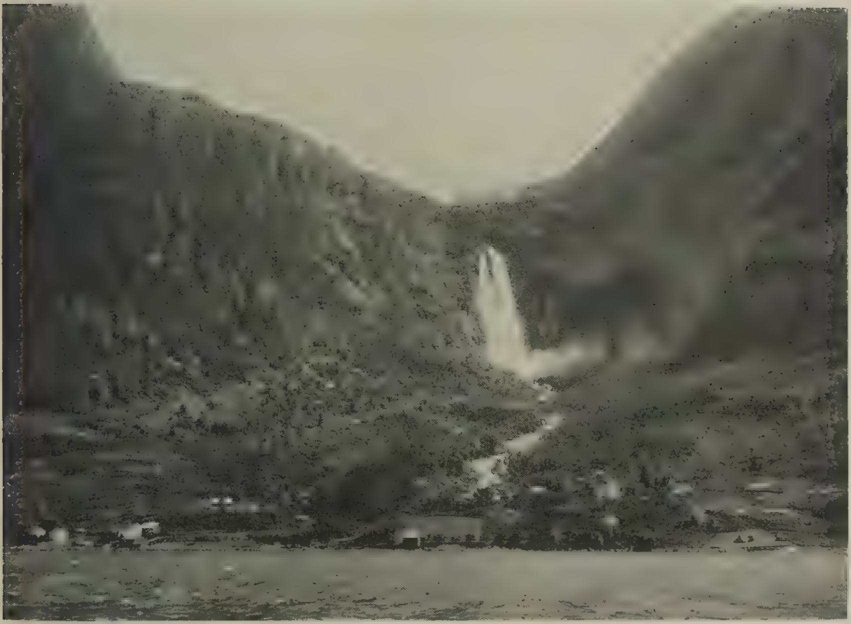

FIG. 22

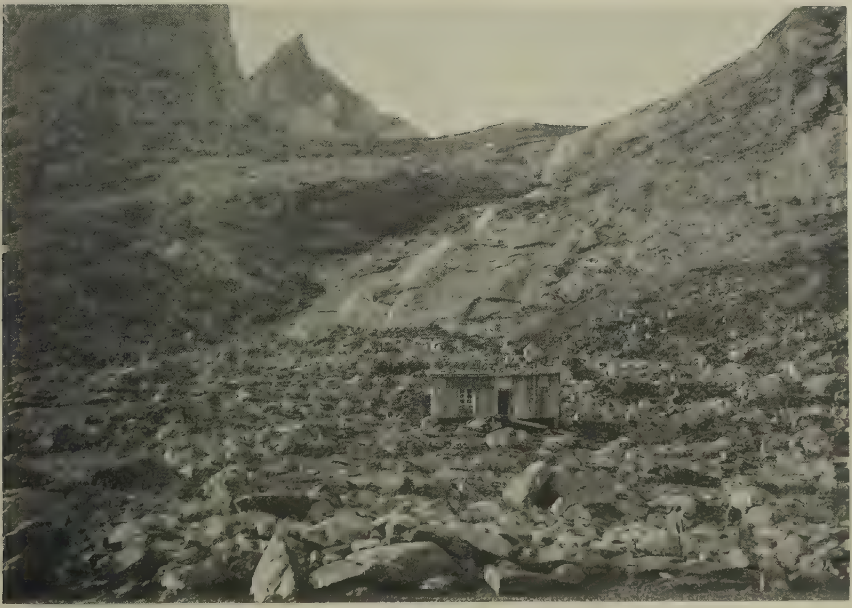

FIG. 23

FIG. 22—Feigum on Lysterfjord, Sognefjord. The waterfall from the hanging valley drops about 480 meters into the glacially overdeepened fiord. In front of the fall a bit of open country covered with glacio-fluvial deposits, which supports a few farms.

FIG. 23—Moskenesö, Lofoten, at the lower end of Djupfjord, showing the extremely barren state of the country. In the foreground the modest home of a fisher family.

Early Settlement in the Interior and on the Coast

The districts which attracted the earliest agricultural settlers in Norway were the large low islands of Westland[17] and the country surrounding the fiords, open and readily accessible, and where the ground was easily worked, conditions filled in the inner parts of Eastland around the lower parts of the great valleys—Österdal, Gudbrandsdal, and Valdres. Then, as now, the Silurian districts possessed many advantages. Settlement seems to have been made mainly on the higher ground. During the Iron Age it became clearly concentrated on the mid-slopes of the valleys, sunny and well drained. Brögger and Shetelig[18] maintain that in Westland the population which had adopted permanent dwellings in consequence of the introduction of agriculture largely retained the old fishing and hunting grounds out on the coast. Serious occupation of the forest-clad interior did not begin until iron had placed in the hands of man an easier means of clearing the land. Here the process of colonization advanced mainly along the sides of the valleys and more particularly in their upper sunny parts. Towards the close of the Viking Age (eleventh century) the habitable parts of the country had for the most part been taken into possession, even though settlement within them was thin and scattered. In Eastland, according to M. Olsen[19], the larger number of the old settlements remained comparatively unchanged until the great development of the twelfth and thirteenth centuries brought about expansion in the forest, up the heights, and down the valley sides. Summer pastures also became permanent farms. Mountain pastures had early been occupied, especially in the great valleys of Eastland, where the precipitation is small (250–600 millimeters). Here, according to Brögger, the present zone of mountain pastures was in use as early as the sixth to eighth centuries of our era. Hunting also continued to play a great part. These two occupations involved seasonal migration on a large scale.

A large number of the old hunting centers along the coast were inhabited only during the season, but others with some cultivable soil acquired a sedentary population with fishery as the main source of livelihood. As certain kinds of fish, such as cod, appear in huge quantities at definite times and at places which have only very little cultivable soil and possess no possibility of providing for any appreciable settled population (e. g. the Lofoten Islands), there arose quite early an extensive seasonal migration amongst the coastal population.

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[17] In the following pages the name "Westland" is used to denote the western part of Norway south of Trondhjem Fjord; "Eastland" to denote the eastern part of that area; "Northland" to denote the region between Trondhjem Fjord and latitude 70° N.; and "Finnmark" to denote the region northeast thereof as far as the Russian boundary.

[18] A. W. Brögger: Norwegische archæologie; and Haakon Shetelig: Archéologie norvégienne, Inst. for sammenlignende Kulturforskning, Oslo, 1925.

[19] M. Olsen: Ættegård og helligdom. Inst. for sammenlignede Kulturforskning, Oslo, 1926.

Owing to the extraordinary wealth of the Norwegian coast in skerries and fiords and to the fact that fish early became an article of international commerce, the towns of Norway mostly belong to the littoral series. Several such towns came into existence in the thirteenth century. According to Bull, the chief agent in their creation in Norway was the Church, especially in its capacity of founder and owner of great landed estates. It is highly probable that on these estates, as was also the case in Germany, the monks introduced a better and more rational system of farming. This was one of the most important economic prerequisites for the rise of a burgess class in the town in their capacity of consumers of the agricultural surplus.

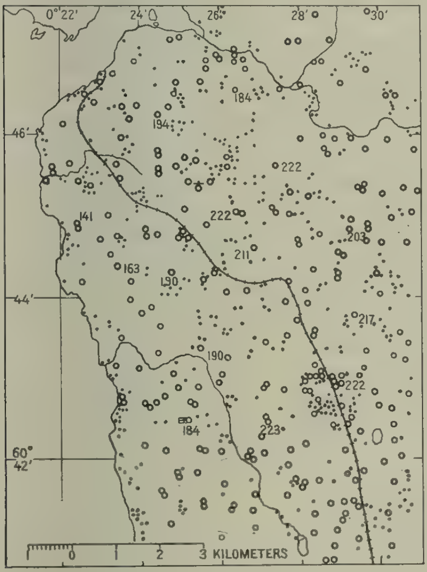

FIG. 24

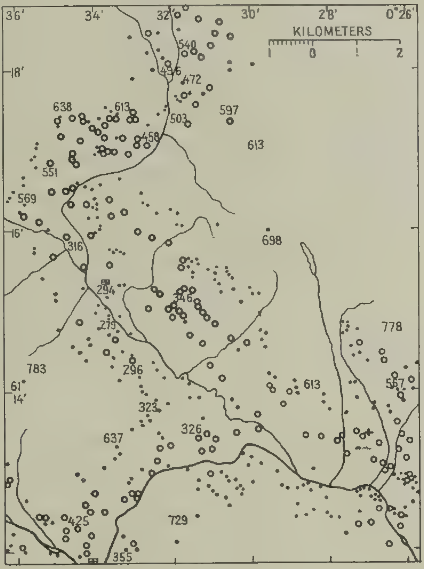

FIG. 25

FIG. 24—The district round Stange near Mjösen, 10 kilometers south of Hamar. Scale 1:170,000. The circles mark fairly large farms; the dots mark smaller farms and also dwelling houses of the non-agricultural population; the figures indicate meters above sea level. The markedly scattered nature of the settlement is the most distinctive feature of the district. (After the topographical map on the scale of 1:100,000, No. 26 A., Hamar.)

FIG. 25—Öst Gausdal, with adjacent districts, 25 kilometers northwest of Lillehammer. Scale, 1:170,000. The circles indicate fairly large farms, the dots mark smaller farms and also summer pasture dwellings and dwelling houses unconnected with agriculture; the figures indicate meters above sea level. (After the topographical map on the scale of 1:100,000, No. 31B., Gausdal.)

The coastal towns of Norway were planned in relation to the water. In contrast to the towns of central Europe, they were not fortified until, in the sixteenth and seventeenth centuries, simple defenses in the form of wooden stockades were erected. Bergen, dominating practically the whole of the Atlantic coast of Norway and the Arctic coast as far as the Russian boundary, became the most important town in Norway and one of the most important members of the German Hanseatic League. The settlement of Northland was thereby retarded.

The introduction of water-driven sawmills, probably at the beginning of the sixteenth century, initiated the first real economic gain since the early progress of fisheries and agriculture. Exploitation of the forests at first chiefly affected settlement on the southern and eastern coast, within which the great forest expanses lie. Here arose many small exporting and trading centers, which afterwards became concentrated into a smaller number of larger ones. Among these last Drammen is the most important. On the Atlantic coast fishery was improved during the latter half of the seventeenth century, partly through the invention of new implements and partly through the curing of cod as klipfish. In consequence rivals to Bergen sprang up in the form of new towns south of the Trondhjem Fjord.

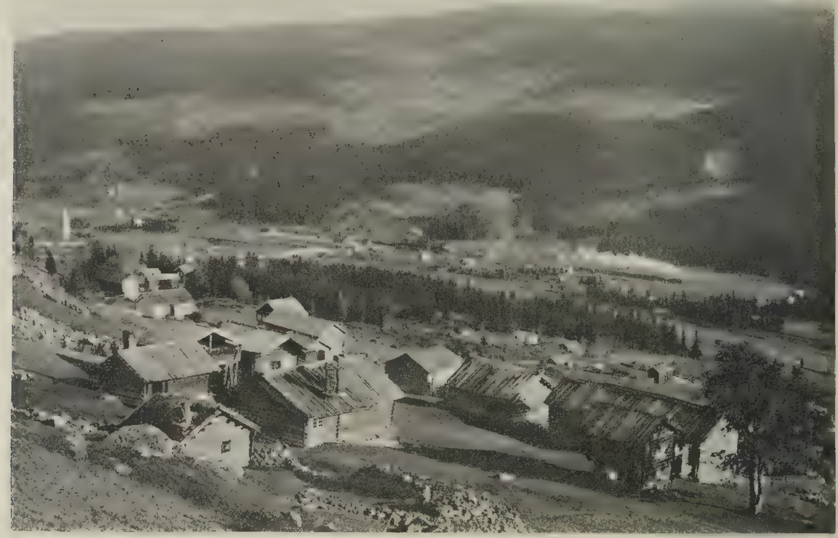

FIG. 26—Ål in Hallingdal. The old settlement situated on the valley side, the cultivated land lying in forest clearings. The sunny northern side of the valley is more cultivated and more abundantly peopled than the southern side. A small station community has sprung up around the railway station on the Oslo-Bergen railway. (Photograph by Wilse.)

LATER SETTLEMENT IN THE INTERIOR AND ON THE COAST

The increased value of the forests after the middle of the sixteenth century accelerated the downward movement of settlement. Farmsteads were chiefly isolated but in certain districts collected in

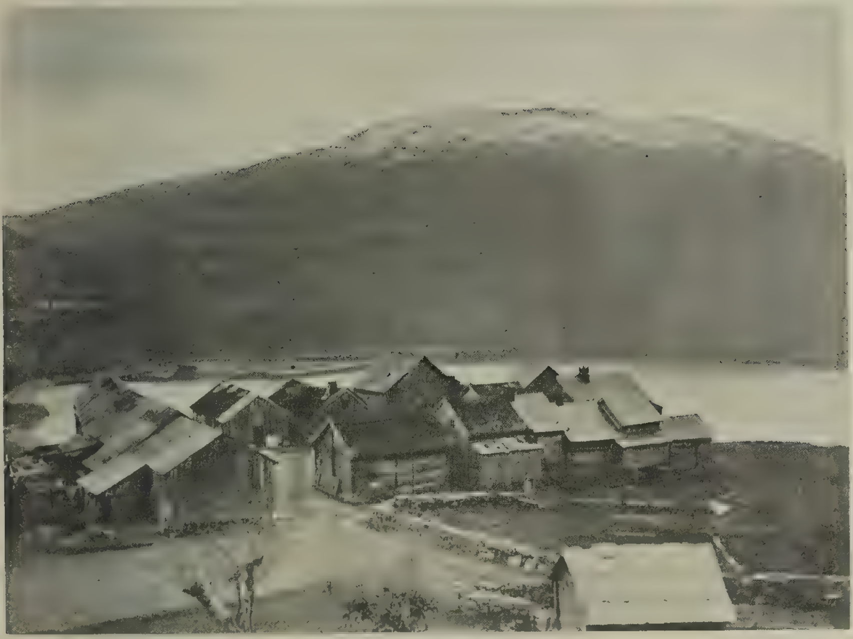

FIG. 27

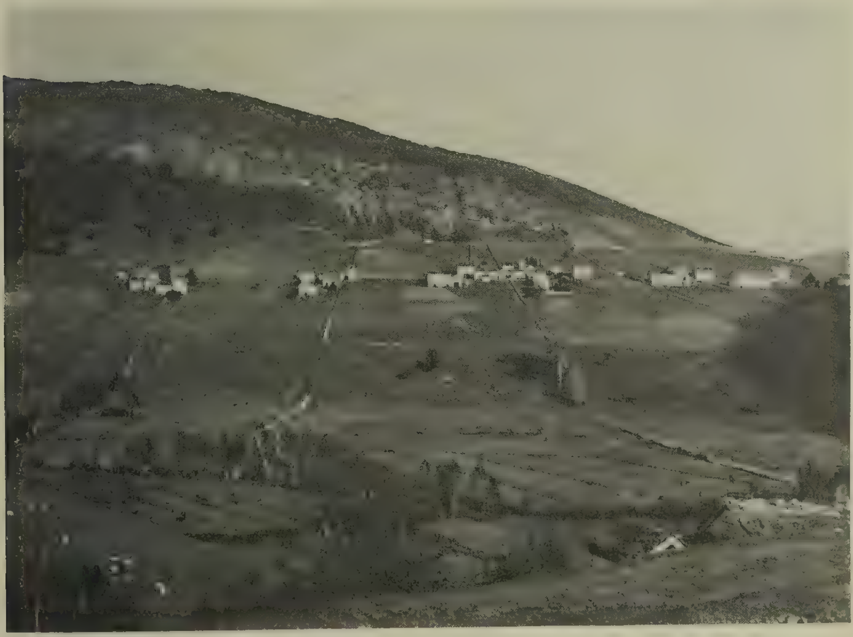

FIG. 28

FIG. 27—A still-surviving *graend* at Voss between Hardanger and Sogne. (Photograph by S. Hasund, 1914.)

FIG. 28—Scattered farms after redistribution of holdings at Söndfjord in Westland. Each group of buildings indicates a farm except the second from the right, which comprises two farms. These latter mark the place of the old farm group of *graend*. The farms are all situated on the upper edge of the unconsolidated deposits, high above the still uninhabited floor of the valley. (Photograph by S. Hasund, 1913.)

small irregular groups known as "graender." The larger farms might consist of twenty to fifty separate buildings which lay quite open, often not even enclosed by a fence. The supply of building timber was practically unlimited, and also the space for building sites.

The introduction of more modern plows of an English type in the middle of the eighteenth century and the commencement of a rational system of highway construction towards the end of the same century proved two important factors of progress, especially in the more open Eastland. Here the use of mountain pasture diminished or was entirely abandoned. Small commercial agglomerations arose in the lower districts, a tendency which continued at a heightened pace when the industrial age, with a consequent increase of money economy, at length made its way into the country. The tradition of many centuries was broken, and the isolation of the various settled districts diminished; people continued to move down from the higher districts, badly situated with regard to communications, and to foregather more and more at the traffic centers; and manufacturing districts grew up, even though their number and size do not yet correspond to the immense resources of the country in water power.

An increased scattering of settlement concomitant with the downhill movement does not appear so distinctly here as in the countries previously examined, because the country was thinly peopled and settlement probably dispersed from the beginning. But a wider distribution of population was encouraged by greater liberty in the choice of dwelling places. As in Denmark, a rearrangement of holdings under pressure of the state broke up most of the old "graender."

The introduction of steam vessels had vast consequence for the coast. The hegemony of Bergen was broken down; and new towns arose, even in the backward parts of Northland and Finnmark. Settlement on the south coast was greatly affected by the establishment of the great steam sawmills, and that south of Bergen by the return of the herring to these waters in the middle of the nineteenth century. Several great manufacturing centers, deriving their energy from the waterfalls of the interior, were established on the seaboard. Where the littoral series meets the most richly developed settlement in the interior, at the head of the Oslo Fjord, Oslo rapidly grew into the largest town in the country with a population of 252,830 in 1925.

The Stages in the Settlement Series and Density of Population

It is probable that the stages in the settlement series of the different regions also follow a general law with regard to density of population in both rural and urban districts. In Zeeland for decades the density of the agricultural population has been about 60 per square kilometer;

and from the south of Italy I have given series of population densities that are characteristic of certain stages of development in the growth of settlement in that country. These stabilized conditions do not change until such inventions are made or such events occur as effect an entire transformation. In the subtropical region horticulture and irrigation have played that part. In Germany the growth of agriculture and the increased importance of a money economy during the Middle Ages, at least, very greatly promoted the rise of towns—a fact which is one of the most remarkable events in the history of settlement in the Teutonic countries. In Denmark the gradual improvement of agriculture led to the perfection of the village type of settlement, but later the redistribution of holdings had a revolutionary effect on that country. In Norway the preparation of dried fish and later of klipfish gave rise to the development of the towns of Westland.

Summary

In order to illustrate the point of view which I present for the geographical study of settlements, I have endeavored, as briefly as possible, to relate certain circumstances in the historical development of settlements and their state at the present time. The four territories discussed belong to three European regions, primarily defined climatologically. It is necessary to know something of the historical sequence of events in order to understand the present character of settlement. By means of it I have also tried to show that in topographically different districts of these regions settlement shows development in relation to the natural and social conditions in such a manner that one can speak of a regular settlement series evolving according to a definite law. At least this conception may be taken as a working hypothesis.

Within the subtropical settlement region, the history of settlement in Sicily illustrates particularly well the development of the general and littoral series, which is again well exhibited in its principal features in the other districts too. The Crati valley shows this, as well as Basilicata, in which the extremely unfavorable physical geographical conditions have retarded settlement in the first stage of the general series. In Apulia, the fruitful Bari district shows how settlement can progress to dispersion in connection with an increased and highly developed cultivation of the ground. Campania is an example of an exceptionally fruitful, overpopulated plain, where settlement is still strongly agglomerated, which adds to a large extent to the misery of the social and material conditions. The development of the general settlement series has been applied in regard to Rome as a significant explanation of the much discussed problem of the city's swift and powerful growth. In other parts of Italy the first stage still holds over certain areas, but a downward move and dispersion of settlement is now making itself strongly felt.

The origin of the medieval towns of Germany, belonging to the humid, temperate region, characterized the development of the fourth stage of the general series and took place in connection with an important phase in the advancement of material culture there. In Denmark, belonging to the same region as Germany, the history of settlement shows features which remind one of those in Italy. The agrarian redistribution has been a powerful means of breaking up villages and extending settlement in order to obtain better results from the agricultural possibilities. In Norway, belonging to the subarctic region, the littoral series is the most important and has followed the same course of development as in Sicily. In the development of the mountain series a tendency to move downwards is found to recur many times. This series owes its character, for the rest, to the fact that settlements in all times have been chiefly scattered.

ON COTIDAL MAPS

H. A. Marmer

U. S. Coast and Geodetic Survey

ON maps delineating the features of the earth, the sea is generally pictured as a vast plain undistinguished by any marks of whatever kind. Even when contour lines or soundings are shown in ocean areas it is to the land that they refer—to the land beneath the sea. The surface of the sea, however, is not a monotonous plane stretching from horizon to horizon. For altogether apart from the swells and waves which are brought about in the surface layers of the water by the play of wind and weather, the sea sustains periodic changes in response to the mighty pulse of the tide-producing forces. Twice daily, in rhythmic fashion, the tide-producing forces of sun and moon stir the sea to its depths and give rise to the phenomena which for short are called the tide.

In so far as our knowledge of the tide is based on observed data, it may be said to be confined wholly to the coast line. The difficulties involved in measuring the rise and fall of the tide in the open sea are obvious, and as yet there are no such observations at hand. To be sure the mid-ocean islands interrupt, here and there, the wide expanse of tidally unknown seas; but these islands are few in number. Moreover, the tide rising and falling on the island shores is no longer the unaffected open ocean tide; for in breaking the uniformity of the ocean depths, the islands by the same token modify the tide.

It may perhaps not be out of place here to emphasize the fact that the tide has its birth in the open ocean basins. It is the action of the tide-producing forces of sun and moon on the waters of these huge basins that makes possible the rise and fall along the coast. What, geographically, is the course of the tide across the oceans? How can the progress of the tide from place to place be pictured? It is these questions that cotidal maps attempt to answer.

COTIDAL LINES AND COTIDAL HOURS

The term "cotidal" appears to have been coined by Sir John Lubbock in 1831. In his paper "On the Tides in the Port of London" he speaks of "*cotidal* lines," adding in parenthesis "I mean the series of points at which it is high water at the same instant."[1] A cotidal line is thus a line connecting points on the ocean at which high water occurs simultaneously.

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[1] J. W. Lubbock: On the Tides in the Port of London, *Philos. Trans. Royal Soc. of London*, Vol. 121, 1831, pp. 379–415; reference on p. 382.

To show the progress of the tide from place to place the cotidal lines must be numbered in some way. This means that some zero time of tide must be established. Since, as it is colloquially put, "the tide follows the moon" it is of advantage to take the time of the moon's passage across some meridian as the zero hour, and for this purpose the meridian of Greenwich naturally suggests itself.

Now the average period of the tide (the time interval from one high water to the succeeding high water, or from one low water to the next low water) is 12 hours and 25 minutes, or half a lunar day. Obviously, it will be of advantage to have this interval divided into equal parts, which solar hours will not do. But it may be done very conveniently by dividing it into 12 lunar hours, which means that each lunar hour is 1.035 solar hours. Cotidal maps, therefore, are generally drawn with cotidal lines numbered from 1 to 12 (12 being used in preference to 0), the time being lunar time referred to the moon's transit across the meridian of Greenwich as the zero hour.

It has been customary for many years to define the time of tide at a place by its relation to the time of the moon's local transit. For the high water this interval is known as the high water lunitidal interval and gives the hours and minutes (in solar time) by which, on the average, high water at that place follows the moon's local meridian passage. It is important to note that the times shown on cotidal maps are not the lunitidal intervals; and, to distinguish between the two, the time of high water at any place as determined in Greenwich lunar time is called the cotidal hour.

The relation subsisting between the lunitidal interval and the cotidal hour at any place can be readily determined so that they may be converted one into the other. Stated briefly, the high water lunitidal interval at any place may be reduced to the cotidal hour by dividing by 1.035 and adding one-fifteenth of the longitude if west, or subtracting if east. Thus Atlantic City, N. J., in longitude 74° 26′ W., has a high water lunitidal interval of 7 hours, 13 minutes. Its cotidal hour therefore is $(7.217/1.035) + (74.43/15) = 11.93$ hours. The advantage of using cotidal hours is that it makes the tide at all places directly comparable in time, which is not the case with lunitidal intervals.

Earliest Cotidal Map

Some twenty years before Lubbock's use of the term "cotidal lines" the idea of representing the progress of the tide by a system of lines was put forward by the English physicist, Dr. Thomas Young; and in his "Natural Philosophy," published in 1807, he illustrates the progress of the tide around the British Isles by such a system of lines.[2] His map, reproduced in Figure 1, is the first cotidal map known, but it is clear that Young intended it more in the nature of an illustration than as a definite attempt to depict the precise course of the tide.

Lubbock's paper "On the Tides in the Port of London," to which reference has already been made, was illustrated with two maps, "the one showing the time of high water on the coast of Great Britain, the other throughout the world, or at least in as many places as it has been ascertained."[3] He makes no attempt to draw cotidal lines but contents himself with noting the cotidal hours at a number of places along the various coasts. With regard to these cotidal hours, however, he remarks, "It will be seen that the continents alter the direction of the cotidal lines . . . and that the progress of the tide is not always from east to west: in the Atlantic it is from south to north; so that it is high water at nearly the same time on the coast of Portugal and on the opposite coast of America."[4]

In explanation of Lubbock's remark that "the progress of the tide is not always from east to west" it is to be observed that the notion of a westward movement of the tide across the seas was one of long years' standing. For it was argued that since the tide follows the moon, the progress of the tide must be from east to west; and therefore the tide was conceived as a wave moving westward following the moon.

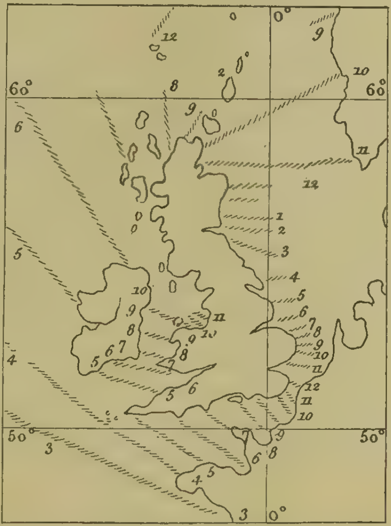

FIG. 1—Thomas Young's cotidal map of the British Isles, 1807. This is the earliest example of a cotidal map known.

It should be noted that Young in his cotidal map joined two points on opposite shores having the same cotidal hour by a straight line. In narrow seas this procedure appears reasonable as a first approximation. But, when it comes to ocean areas, such procedure is altogether too simple to fit the facts. In other words, across the open sea cotidal lines can be drawn only in accordance with certain assumptions as to the nature of wave movement, or in consonance with some theory of the tide.

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[2] Thomas Young: A Course of Lectures on Natural Philosophy and the Mechanical Arts, 2 vols., London, 1807; reference in Vol. 1, p. 582.

[3] Lubbock, *loc. cit.*, p. 382.

[4] *Ibid.*, p. 382.

Whewell's Cotidal Map

The first comprehensive cotidal map of the world is due to William Whewell. In 1833 he presented before the Royal Society of London a paper entitled "Essay towards a First Approximation to a Map of Cotidal Lines."[5] Two cotidal maps accompany the paper, one for

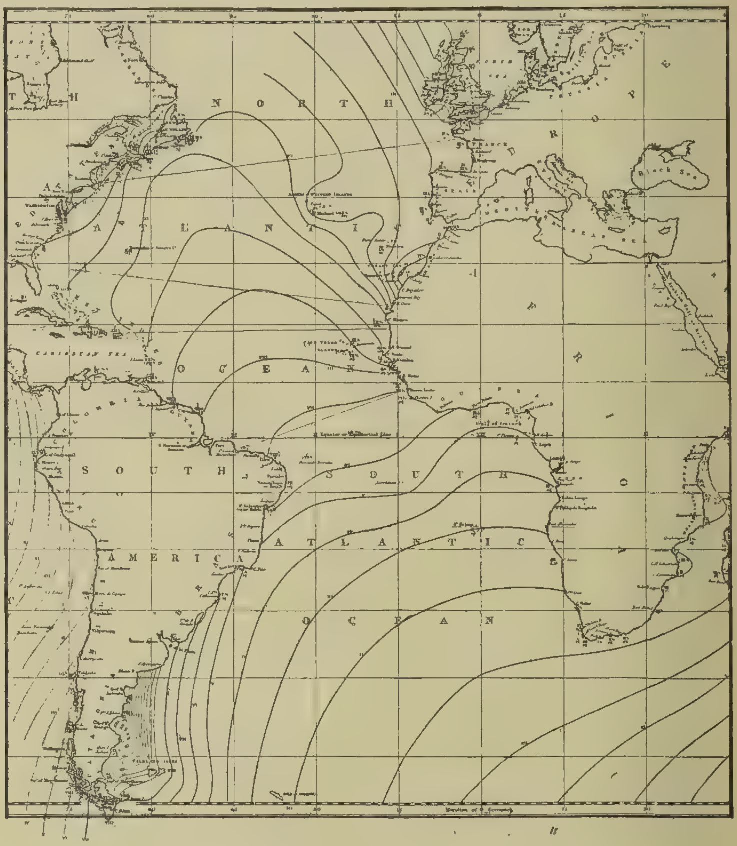

FIG. 2—Whewell's cotidal map of the Atlantic Ocean.

the British Isles and the other for the world at large between the latitudes 60° N. and 52° S. In the latter of these maps the cotidal lines are drawn across the wide expanses of the Atlantic and Indian Oceans from shore to shore; but in the Pacific Ocean the cotidal lines, because of the meager information at hand at that time, go out but a short distance from the western coast of the United States. Note may be made, however, of a number of cotidal lines across the Southern Pacific from Chile to the Friendly Islands. In Figure 2 the cotidal lines for the Atlantic Ocean are reproduced from Whewell's map.

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[5] William Whewell: Essay towards a First Approximation to a Map of Cotidal Lines, *Philos. Trans. Royal Soc. of London*, Vol. 123, 1833, pp. 147–236.

As a preliminary to drawing his maps Whewell considers the form cotidal lines must have in virtue of the laws of fluid motion. He shows that they must be convex in the direction of wave progression, because the tide wave will progress faster in the deeper central part of a channel than in the shallower areas near the shores. He considers also the effects of islands and shoals, concluding that these must deflect the course of the cotidal lines in their vicinity.

Whewell expressly states that he endeavored "to trace the course of the cotidal lines according to which the tide is actually propagated in the Ocean."[6] In other words, he makes it plain that he was basing his map on observations so far as possible rather than on an a priori theory of the tide. He was fully aware of the difficulties involved in securing accurate tide observations and the further difficulties of correcting the data derived from short series of observations to mean values; and he is scrupulously careful to make it clear that he is endeavoring "to draw a first approximation to the course of the cotidal lines, begging the reader to bear in mind that from the nature of our materials it must be imperfect."[7] Finally, in the conclusion to his memoir he adds, "I shall be neither surprised nor mortified if the lines which I have drawn shall turn out to be in many instances widely erroneous; I offer them only as the simplest mode which I can now discover of grouping the facts which we possess."[8]

If there were sufficient tide observations in the open sea the construction of a cotidal map would offer no more difficulty than the drawing of a contour map of a well-surveyed area; but tide observations are confined wholly to the coast line. In Whewell's case the difficulty was aggravated by the absence or meagerness of accurate observations over wide stretches of the coast. Under such conditions some theory of the tide must, obviously, underlie the construction of a cotidal map.

Parenthetically it may be observed that in speaking of a "theory" of the tide no question is raised thereby as to the moon and sun being the agencies that give rise to the tide. Nor is there any question as to the tide-producing forces brought about by the attraction of moon and sun, for these are well known and can be readily determined from known astronomical data. But taking these tide-producing forces for granted, what is the precise nature of the movement of the ocean waters in response to them?

Progressive-Wave Theory

Underlying Whewell's cotidal map is the so-called "progressive-wave" or "Southern Ocean" theory of the tide. This theory considers the tides of the world as due primarily to the action of the tidal forces of moon and sun on the broad and deep waters of the Southern Ocean, the belt of water that completely encircles the earth south of the great land masses. Here it is argued, the tidal forces have almost uninterrupted sway, and here these forces raise two tidal waves 180° apart in longitude, which travel from east to west. As each of these waves sweeps past the Cape of Good Hope it generates a wave which travels up the Atlantic Ocean, and it is this secondary wave generated by the primary tidal wave of the Southern Ocean which determines the tides on the shores washed by the Atlantic.

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[6] *Ibid.*, p. 156.

[7] *Ibid.*, p. 163.

[8] *Ibid.*, p. 235.

It is important to note carefully the distinction between the primary tidal wave and the secondary wave which, according to this theory, sweeps up the Atlantic Ocean. The secondary wave travels freely, according to depth. But the primary tidal wave in the Southern Ocean keeps step with the moon; it travels not as a "free" wave, but as a "forced" wave, compelled by the moon to keep in time with its own movement.

At Whewell's instance simultaneous tide observations were made in 1835 at a number of places both in Europe and in America. In reporting on the results of these observations he states, "It is not surprising, therefore, that the differences between the form of the [cotidal] lines now obtained and my former maps should be considerable. At the same time I may observe, that all my views of the general course of the tide-wave have been confirmed by the present examination."[9] As a result of these newer observations he presents a revised cotidal map of the waters around the British Isles, but not for the world at large. It is of interest to note, however, that from the study of these more recent observations Whewell finds a number of difficulties in the notion of the progress of the tide wave from south to north in the Atlantic Ocean.[10]

The progressive-wave theory is very plausible and explains a number of features of the tide as they manifest themselves in the seven seas. To the end of the nineteenth century the greater number of tidal investigators, and in turn the geographers, lent the weight of their authority to the progressive-wave theory and to Whewell's cotidal map. In his article on "Tides and Waves" Sir George Airy, whose contribution to the mathematical development of tidal theory was considerable, directs attention to the fact that the cotidal lines in the other seas cannot be considered as known with great certainty; but with regard to the North Atlantic he remarks, "We conceive therefore (recognizing also the justness of the principles on which Mr. Whewell has generally drawn his curves) that the cotidal lines of the

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[9] William Whewell: Researches on the Tides: Sixth Series, *Philos. Trans. Royal Soc. of London*, Vol. 126, 1836, pp. 289–341; reference on p. 294.

[10] *Ibid.*, p. 304.

Northern Atlantic are now drawn with very great accuracy."[11] He reproduces Whewell's cotidal map of the world[12] with the corrections indicated by Whewell in his memoir of 1836. Five years later Heinrich Berghaus reproduces Whewell's map of 1833 with no corrections; he adds, however, cotidal lines for the Pacific Ocean.[13] These latter he draws in dotted lines for distinction from those laid down by Whewell, which are shown in full lines, explaining in a legend that the full lines are certain while the dotted lines are uncertain. Even so late as 1911 Airy's cotidal map is reproduced by Darwin in the third edition of his well known book on the tides,[14] although attention is directed to the assumptions underlying it and to the results of later investigations which call some of these assumptions into question. Darwin goes on to state, however, that "the tide-wave is principally progressive in the ocean."[15]

STATIONARY-WAVE THEORY

A body of water disturbed from its condition of rest tends to set up waves. This is a familiar fact illustrated not only by the ocean waves and swells but in a variety of ways—by the pebble dropped in the pond, the wind disturbing the surface of the lake, the boat plowing through the water. And in the same way the tide-producing forces of sun and moon acting on the waters of the sea bring about the mighty wave which manifests itself as the tide.

It is to be noted, however, that a body of water is capable of sustaining two different types of wave movement. If we take a rectangular tank, say about 20 feet long filled with water to a depth of about a foot, we can start a wave by agitating the water at one end with a paddle. This wave will progress from one end of the tank to the other, the outline of the wave being the sinuous curve which we generally associate with wave movement. This wave is technically a progressive wave.

But we may also set up in the tank of water a wave movement of an entirely different kind by raising and then immediately lowering one end of the tank. The water will now no longer progress from one end to the other, but will oscillate or swash about an axis in the middle of the tank, so that it will be high water for half the tank at the same instant that it is low water in the other half. This type of wave is known as the stationary wave.

On the basis of the progressive-wave theory the rise and fall of the tide was conceived as a world phenomenon dominated by the forced tide wave of the Southern Ocean. But a study of the results of the more numerous tide observations since Whewell's time brings out the fact that, while the characteristic features of the tide in the various oceans differ considerably, for any one ocean basin these characteristic features are much the same. Is it not, therefore, more probable that the tides in the various oceans are brought about by the action of the tide-producing forces on the waters of the individual oceanic basins, each basin responding in accordance with its geographic make-up? Furthermore, may not the rise and fall of the tide in the open ocean be due to a stationary wave rather than to a progressive wave?

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[11] Encyclopaedia Metropolitana, Vol. 5, London, 1845, p. 390.*

[12] *Ibid.*, Pl. 6.

[13] Heinrich Berghaus: Physikalischer Atlas: Allgemeiner Hydrographischer Atlas, Gotha, 1850.

[14] G. H. Darwin: The Tides and Kindred Phenomena in the Solar System, 3rd edit., London, 1911, p. 194.

[15] *Ibid.*, p. 198.

From time to time various investigators had put forward the suggestion that certain features of the tide could best be understood on the assumption that the response of the waters to the tidal forces of sun and moon was of a stationary-wave character. Indeed, Whewell himself, some fifteen years after the publication of his cotidal lines thinks it unlikely that the progressive wave in the Atlantic and Pacific Oceans which his scheme of cotidal lines assumes "rightly represents the mode in which the waters of the Atlantic and Pacific obey the action of the sun and moon" and adds, "If it be asked what other mode of operation of the lunar and solar forces upon the ocean can be conceived, different from this progressive wave which is expressed by means of cotidal lines; an answer immediately suggests itself, that a *stationary undulation* . . . is a possible mode of motion for a fluid under such circumstances."[16]

As a result of his later researches Whewell is "disposed to retract parts of what I have said with regard to the form of the cotidal lines of the Atlantic in my 'Essay.' I do not think it likely that the course of the tide can be rightly represented as a wave travelling from south to north between Africa and America."[17] For the wide expanses of the open sea Whewell definitely discards the cotidal lines previously laid down by him. It is a curious fact, therefore, that despite this his cotidal map was reproduced in various books for many years thereafter.

Stationary-wave movements as related to tides received considerable mathematical discussion in the tidal researches of William Ferrel. He concluded that the tide in the North Atlantic Ocean was due primarily to an east-and-west stationary-wave oscillation. He discarded completely the notion of a progressive wave sweeping up the Atlantic from the Southern Ocean and emphasized his views by the statement, "If there were a dike extending from the Cape of Good Hope to the coast of South America, the tides of the North Atlantic Ocean would most probably be very nearly the same."[18]

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[16] William Whewell: Researches on the Tides: Thirteenth Series, *Philos. Trans. Royal Soc. of London*, Vol. 138, 1848, pp. 1–29; reference on p. 3.

[17] *Ibid.*, p. 5.

[18] William Ferrel: Tidal Researches, Appendix, *U. S. Coast Survey Rept. for the Year 1874*, Washington, 1874, p. 239.

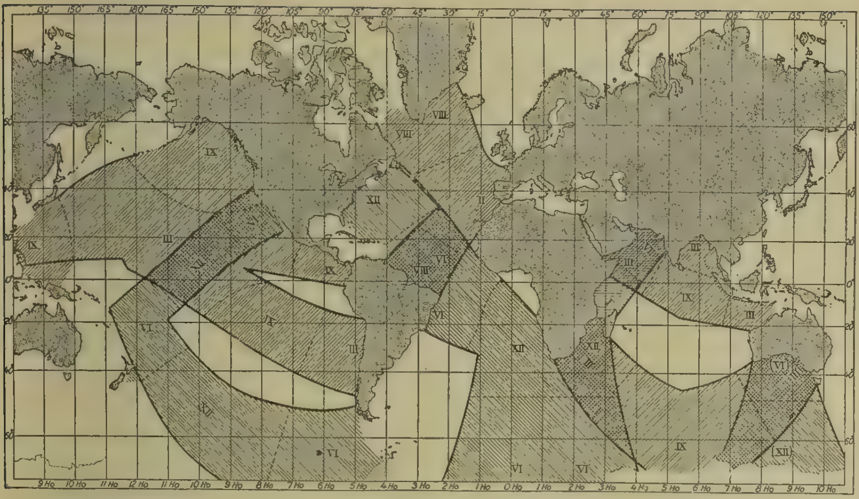
135° 150° 165° 180° 165° 150° 135° 120° 105° 90° 75° 60° 45° 30° 15° 0° 15° 30° 45° 60° 75° 90° 105° 120° 135° 150°
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FIG. 3—Oceanic oscillating systems for the semi-daily tide-producing forces, according to Harris.

Oceanic Oscillating Systems

It was however, not till the beginning of the present century that the stationary wave was made the basis of a full-fledged theory of the tide. In 1901 Harris published his "Outlines of Tidal Theory."[19] This is primarily a mathematical discussion of the modes of oscillation of bodies of water. Harris' thesis is that the tide in the open sea is brought about by stationary-wave movements of various oceanic areas which he denominates as "oscillating systems," these systems having free periods of oscillation which are approximately the same as the periods of the tide-producing forces.

The period of oscillation of a body of water depends on its length and depth. Since the principal tidal forces are those having a period of half a lunar day, Harris separated out oceanic areas which have the requisite length and depth to support stationary waves with a period of half a lunar day. These oceanic areas constitute the "oscillating systems" and are illustrated in Figure 3.

The Roman numerals on the oceanic oscillating systems of Figure 3 give the cotidal hours over the areas indicated. Several of the oscillating systems overlap, and these are distinguished by different kinds of shading. The nodal lines of the various systems are indicated by dashed lines across the shaded areas. The unshaded parts of the ocean are areas of such size and depth that the action of the tide-producing forces on these areas can produce but little tide. In such regions, therefore, the tides that occur are due to the tides produced in the neighboring oscillating areas.

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[19] R. A. Harris: Manual of Tides, Part IVA: Outlines of Tidal Theory, *U. S. Coast and Geodetic Survey Rept. for the Year Ending June 30, 1900,* Washington, 1901, pp. 535–699 (Appendix No. 7).

According to the stationary-wave theory, the tide-producing forces of sun and moon as they sweep over the oceans maintain a stationary-wave oscillation in these open ocean systems, the rise and fall being greatest at the ends and least at the nodal lines. These oscillations give rise to the dominant semidaily tides of the world. Openings in the coast line and irregularities in depth cause the stationary-wave tides generated in these ocean basins to send off progressive waves into coastal tidal waters, or into other parts of the sea.

South of Australia, Figure 3 shows an oscillating area in which the cotidal hours are enclosed in parentheses. This area lying between Australia and the Antarctic Continent is of such length and depth that its period of oscillation is more nearly that of the solar tide-producing forces than of the lunar. Consequently, the tides here should show a relatively large solar constituent. And the results of analyses of tide observations made on the southern coast of Australia prove this to be the case.

A number of puzzling features of the tide in various regions are explained nicely by the stationary-wave theory. Such diverse manifestations of the tide as the relatively large rise and fall on the Atlantic coast of the United States as compared with the small range on the Bahamas and Porto Rico, the small diurnal inequality in the Atlantic Ocean tides, the surprisingly large ratio of the solar to the lunar tide at Tahiti—these phenomena find ready explanation under the stationary-wave theory and Harris' conception of oceanic oscillating systems.

Criticism of Harris' theory has not been wanting. G. H. Darwin, reviewing the "Outlines of Tidal Theory," dissented absolutely from Harris' views and found himself constrained to criticize it adversely.[20] In his "Handbuch der Ozeanographie" Krümmel discusses the oscillating systems and concludes, "Such a conception is mathematically possible, but from our geographic point of view we are compelled to reject these oscillating systems of Harris decisively."[21]

In this connection it is to be observed that the mathematical basis of the theory deals with difficult hydrodynamical questions. The criticism of so well-known an authority as Darwin carried great weight, and his adverse criticism undoubtedly did more than any other cause to bring Harris' theory into disfavor. But in 1910 Poincaré published the third volume of his "Leçons de Mécanique céleste," devoted to the tides. After subjecting the various tidal theories to searching mathematical analyses the great master states "It is probable that the final theory will have to borrow from that of Harris a notable part of its principal features."[22] Poincaré's exposition of Harris' theory has done much to bring it to the fore again.

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[20] G. H. Darwin: A New Theory of the Tides of Terrestrial Oceans, *Nature*, Vol. 66, 1902, pp. 444–445.

[21] Otto Krümmel: Handbuch der Ozeanographie (2 vols., Stuttgart, 1907–1911), Vol. 2, p. 256.

[22] Henri Poincaré: Leçons de Mécanique céleste (4 vols., Paris, 1905–10), Vol. 3, p. 403.

HARRIS' COTIDAL MAP

On the basis of a careful synthesis of the results of the tide observations made to the beginning of the present century, Harris constructed a cotidal map of the world, in which the course of the cotidal lines in the oceanic areas were drawn in consonance with his tidal theory.[23] This map differs radically from Whewell's, as may be seen on comparing the cotidal lines of the Atlantic Ocean in Figures 2 and 4, the former illustrating the cotidal lines according to Whewell and the latter according to Harris.

Along the coast the differences between Whewell's and Harris' cotidal maps arise from the fact that Harris had at his command the results of more numerous and more accurate tide observations. But the most striking differences are not near the coast but in the open ocean. Taking the North Atlantic Ocean, in Whewell's map the tide is shown progressing in a simple manner. In Harris' map there is no such simple progression; instead, there is a point about which the cotidal lines radiate. Such points Harris designated by the name of "amphidromic points."

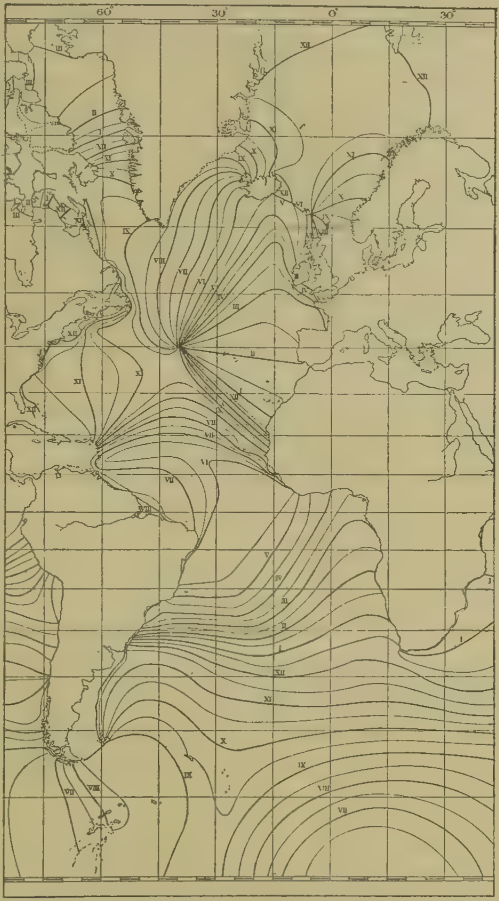

FIG. 4—Harris' cotidal map of the Atlantic Ocean.

As to the causes that bring about amphidromic points, or points of no tide, it is to be remembered that in a stationary wave no rise and fall takes place along the nodal line; hence in a simple stationary-wave movement there is a *line of no tide*. Now suppose that in a body of water there are two simple stationary waves, one in an east-and-west direction, and the other in a north-and-south direction. The first wave gives rise to a line of no tide in the north-and-south direction while in the other wave the line of no tide runs in an east-and-west direction. Where the two lines cross there will manifestly be a *point of no tide;* and a little consideration will show that from this point the cotidal lines will radiate.

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[23] R. A. Harris: Manual of Tides, Part IVB: Cotidal Lines of the World, *U. S. Coast and Geodetic Survey Rept. for the Year Ending June 30, 1904*, Washington, 1904, Fig. 6, opp. p. 400.

In the interest of historical accuracy it is to be mentioned that the concept of a no-tide point had been put forward by Whewell in 1836 to explain the behavior of the tides in the North Sea.[24] However, this was done not on the basis of dynamic principles or in consonance with a particular theory of the tide but to give the most likely interpretation of the observed facts. Later, in discussing types of tidal movements, he mentions the possibility of an oceanic tidal movement with "cotidal lines revolving round a fixed center."[25]

On his cotidal map of the world, Harris places two amphidromes in the North Atlantic (shown in Figure 4), one in the North Pacific, two in the South Pacific, and one in the Indian Ocean. Because of the difficulties involved in the observation of tides in the open sea there are no practical means at the present time for proving or disproving the existence of these oceanic amphidromic points. But on theoretical grounds the existence of these no-tide points appears unquestioned.

Harris' name is associated with another tidal question which is altogether separate from his cotidal map and the theory on which it is based. This is the question of land in the unexplored regions of the Arctic. From his study of Arctic tides Harris was led to conclude that a large tract of land existed in the unexplored region of the Arctic.[26] Recently, however, the features of the Arctic tides on which Harris based his inference of land have been shown to be due to other causes,[27] so that the existence of a large land mass in the Arctic appears very doubtful and can no longer be said to be indicated by the tides. It must be emphasized, however, that this inference of land in the Arctic was in no way based on his stationary-wave theory of the tide in the open ocean, and the failure to find an Arctic land mass would in no way invalidate that theory nor the cotidal map based thereon.

Recent Cotidal Maps

A new cotidal map of the world was published by Dr. Robert Sterneck in 1920.[28] It was based on the fact that an oscillation may be conceived as arising from the interference of two components with phase differences of one-quarter period. This greatly simplifies the mathematical treatment, and on the basis of the actually observed tides along the various coasts and islands Sterneck constructs his map in consonance with hydrodynamic principles. He finds it necessary to place two amphidromes in the Atlantic Ocean, six in the Pacific Ocean, and four in the Indian Ocean. In other words, he has the same number of amphidromic points as Harris in the Atlantic, three more in the Pacific, and three more in the Indian Ocean. Sterneck's cotidal map for the Atlantic is reproduced in Figure 5.

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[24] Article cited in footnote 9, p. 298.

[25] Article cited in footnote 16, p. 5.

[26] R. A. Harris: Arctic Tides, Washington, 1911.

[27] H. U. Sverdrup: Dynamic of Tides on the North Siberian Shelf: Results from the Maud Expedition, *Geofys. Publikasjoner*, Vol. 4, No. 5, Norske Videnskaps-Akad. i Oslo, 1926.

[28] Robert Sterneck: Die Gezeiten der Ozeane, *Sitzungsber. Akad. der Wiss. in Wien, Math-naturw. Klasse*, Abteil. IIa, Vol. 129, 1920, pp. 131–150.

More recently Prof. Defant has drawn a cotidal map for the Atlantic and Arctic Oceans.[29] Starting from the consideration that the Atlantic and Arctic Oceans constitute an enormous canal open only at its southern end—since, in comparison, the narrow and shallow Bering Strait on the north may be totally disregarded—Defant studied mathematically the various oscillations which such a canal can sustain and the relative importance of these various oscillations in bringing about the actual tide. He found that it is the north-and-south stationary-wave oscillation that determines the tide in the Atlantic Ocean.

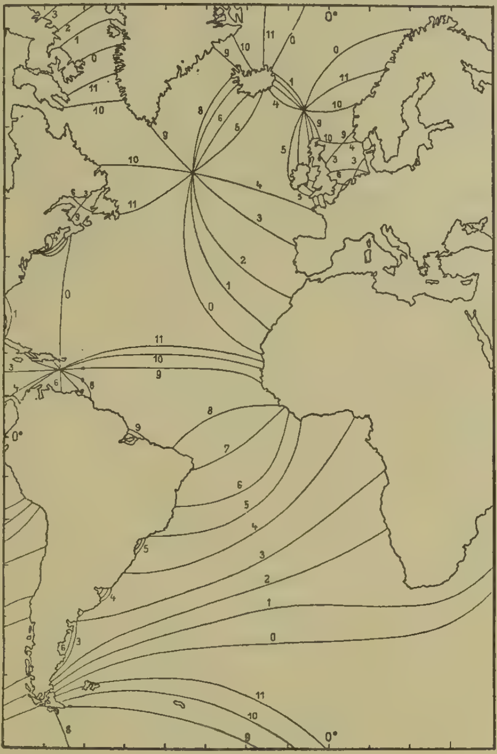

FIG. 5—Sterneck's cotidal map of the Atlantic Ocean.

Defant's mathematical analysis indicates the existence of six primary nodal lines in the canal made up by the Atlantic and Arctic Oceans. The effect of the earth's rotation and of cross oscillations is to eliminate two of these nodal lines and to convert the other four into amphidromic points as shown in Figure 6, which is a reproduction of Defant's map. For the greater part of the Atlantic Ocean the tide behaves as if it were a progressive wave coming from the Southern Ocean; but Defant emphasizes the fact that it is only an appearance, due to the interaction of north-and-south and east-and-west oscillations and not to an actual progressive wave sweeping northward from the Southern Ocean.

Comparing Defant's cotidal map of the Atlantic with those of Harris and Sterneck shown in Figures 4 and 5, a close family resemblance appears, especially in the recognition of the existence of amphidromic points. This is all the more striking since each of these three investigators starts from different theoretical considerations. It may therefore be taken for granted that these cotidal maps represent, in the large at least, the movement of the tide across the open sea.

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[29] Albert Defant: Die Gezeiten des Atlantischen Ozeans und des Arktischen Meeres, *Annal. der Hydrog. und Marit. Meteorol.* Vol. 52, 1924, pp. 153–166.

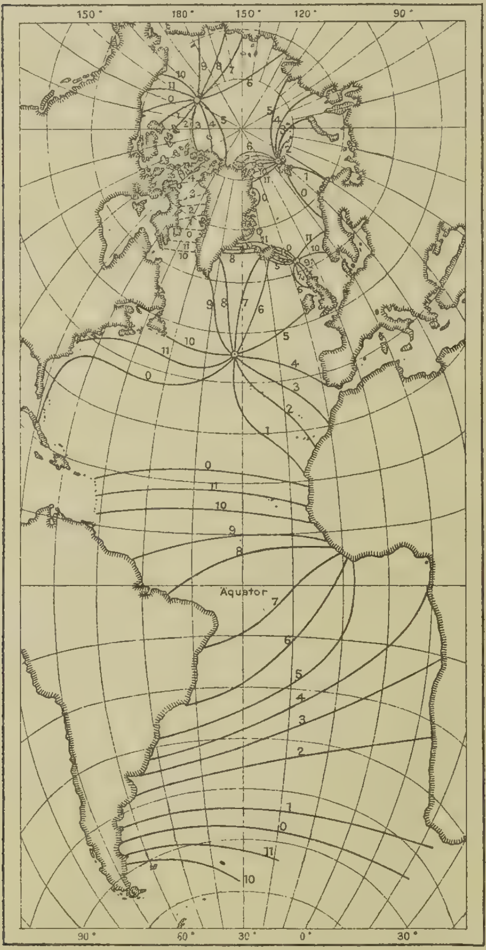

Fig. 6—Defant's cotidal map of the Atlantic Ocean.

The latest cotidal map of the world to date is by Dr. T. J. J. See, who in a recent publication devoted to tides puts forward "a revised cotidal map of the oceans."[30] This is a revision of Whewell's cotidal map and, like the latter, pictures the tide as progressive waves traversing the open sea. Neither Whewell's own objections to this conception nor the criticisms of later investigators appear to have any weight with Dr. See.

Brushing aside the work of Ferrel, Harris, Poincaré, Sterneck, Defant, and other tidal students, Dr. See sets up a new "wave theory" of the tide; but, although making use of considerable mathematical scaffolding, it is unconvincing. Indeed, it has been very severely criticized in a review by Dr. J. Proudman[31] who speaks as a tidal mathematician of recognized authority. Dr. See's cotidal map runs so completely counter to the results of all other tidal investigators of the present time that the author's reputation in other fields cannot be taken as surety for the validity of the mathematical reasoning he advances in support of his thesis.

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[30] T. J. J. See: New Dynamical Wave-Theory of the Tides, *U. S. Hydrogr. Office Publ. No. 207*, Washington, 1926.

[31] *Geogr. Journ.*, Vol. 69, 1927, p. 588–589.

Semidaily Versus Daily Tides

The principal tide-producing forces are those having a period of half a day; and it is for this reason that the tide, the world over with but few exceptions, has a period of half a day. Cotidal maps picturing the tide as it actually takes place, or those based wholly on the semidaily constituents of the tide are practically indistinguishable.

For certain purposes, however, it is important to have cotidal maps of the daily tide. By means of the mathematical process known as harmonic analysis[32] the observed tide at any place may be resolved into its simple constituents. And it is on the results of harmonic analysis that cotidal maps for the daily tide are based. Sterneck has published a cotidal map of the daily tide for the world at large,[33] and Defant one for the Atlantic and Arctic Ocean.[34] In both of these maps amphidromic points constitute the basic features.

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[32] See, for example, Paul Schureman: A Manual of the Harmonic Analysis and Prediction of Tides, *U. S. Coast and Geodetic Survey Special Publ. No. 98*, Washington, 1924.

[33] Robert Sterneck: Die Gezeiten der Ozeane, *Sitzungsber. Akad. der Wiss. in Wien, Math.-naturw. Klasse*, Abteil. IIa, Vol. 130, 1921, p. 372.

[34] Defant, *loc. cit.*, opp. p. 200.

AMERICAN GEOGRAPHICAL SOCIETY

The November Meeting. The first regular meeting of the American Geographical Society for the season 1927–1928 was held on November 22, 1927, at the Engineering Societies Building, 29 West 39th Street, President John H. Finley in the chair. Mr. George Palmer Putnam spoke on "Exploration in Baffin Island," illustrating his lecture with motion pictures. The work of his expedition is described in this number of the *Geographical Review.*

Elections to Fellowship. At the November meeting of the Society, President Finley presiding, there were presented with the approval of the Council the names of 522 candidates who were duly elected as Fellows of the Society.

EXPEDITIONS

The American Geographical Society's Peruvian Expedition. In June the Society sent an expedition to Peru under the direction of Mr. O. M. Miller, of the Society's School of Surveying, to make a topographic survey of the headwater region of the Marañón River in the cordillera of the Andes northwest of Cerro de Pasco and to carry out a number of traverses in the montaña between the Marañón and Huallaga Rivers. The purpose of the expedition was to fill one of the most important gaps in the collection of source material which the Society is assembling for the compilation of its Map of Hispanic America on the scale of 1:1,000,000 and to link together a number of earlier surveys collected from various sources. In a report received October 20, Mr. Miller stated that the survey work in the cordillera had been completed, approximately 1500 square kilometers having been covered by triangulation and topographic surveys supplemented by a large number of photographs and moving pictures.

The Peruvian government has shown much interest in the expedition, has furnished it with a military escort, and has otherwise greatly facilitated its work.

Mr. Joseph H. Sinclair's Expedition to the Ecuadorean Oriente. Mr. and Mrs. Joseph H. Sinclair sailed for Ecuador on August 20 to carry out an important program of exploration and geographical studies in the Ecuadorean Oriente in collaboration with the American Geographical Society. They will continue the surveys and geological reconnaissance work begun by Mr. Sinclair and Mr. Theron Wasson in 1921. (See Joseph H. Sinclair and Theron Wasson: Explorations in Eastern Ecuador; *Geogr. Rev.*, Vol. 13, 1923, pp. 190–210.) The special objective of the expedition is Mt. Sumaco, a volcano which was located by the expedition of 1921 and which the present expedition proposes to study and map. The surveys will be an important contribution to the Society's Map of Hispanic America.

The government of Ecuador is much interested in the objects of the expedition and has greatly assisted Mr. Sinclair in his preparations for the trip.

RECENT PUBLICATIONS

Arabia Deserta: A Topographical Itinerary. This book is Number 2 of the Society's series *Oriental Explorations and Studies*, the first six numbers of which are being published "under the patronage of the Czech Academy of Sciences and Arts and of Charles R. Crane, Esq.," and will comprise the scientific results of Professor Alois Musil's explorations in northern Arabia and Mesopotamia (see *Geogr. Rev.*, Vol. 15, p. 297; Vol. 17, pp. 145, 178).

"Arabia Deserta" deals specifically with the region known to the ancient geographers by that name, the great expanse of stony and rocky deserts and steppes lying between the Hauran Mountains and Wadi Sirhān on the west, the Euphrates on the northeast, and the Nefūd sands on the south. Between November, 1908, and June, 1909, Musil wandered widely over this region, some of the time in company with the Rwala Bedouins, whose head chief, An-Nūri, was his "friend and brother." In 1912 he cut across a part of the eastern edge of Arabia Deserta between Ar-Rumādi and An-Nejef. In December, 1914, and January, 1915, he made his way from Damascus to Al-Jauf, on the first lap of an extended journey in Nejd and Mesopotamia which will be described in detail in subsequent volumes.

To each of these three expeditions is devoted a separate part of the main text of "Arabia Deserta." In addition to the strictly topographical information about the country lying along the author's routes, the narrative is enlivened by many anecdotes which illustrate life in the desert and the mentality of the nomads.

In the appendixes the author deals critically with questions of historical and archeological interest: northern Arabia in the Assyrian period; the Bene Qedem; Arabia Deserta according to the classical and Arabic authors; ancient, medieval, and modern transport routes in Arabia Deserta; various episodes in the history of the oasis of Dūmat al-Jandal (al-Jauf); and the march of the Moslem general Khaled ibn al-Walīd from Iraq to Syria in the dramatic campaign of 13 A. H. (634 A. D.).

The volume is illustrated with some very striking photographs as well as with plans of certain ruins visited by the author.

Map of Northern Arabia 1:1,000,000. This map (in four sheets, printed in black and brown) embodies the results of Professor Alois Musil's explorations of 1908–1915 in Palmyrena, the north Arabian (or Syrian) desert, northern Nejd, and the northern Hejaz; it illustrates Musil's volumes "Arabia Deserta," "The Middle Euphrates," "Palmyrena," and "Northern Neǧd" being published by the Society (see preceding note). The skeleton of the map is based upon astronomical determinations of position, plane-table surveys, and route traverses. Topographical features away from Musil's routes were drawn from information derived from sketch maps and descriptions supplied by the natives. In the expression of the relief and in the recording of place names the map reveals fuller detail than any map that has hitherto been published of the regions in question.

The Leardo Map of 1452 or 1453. In 1906 Archer M. Huntington, Esq., presented to the American Geographical Society a fifteenth-century parchment map of the world (*Bull. Amer. Geogr. Soc.*, Vol. 38, 1906, pp. 365–368) which had been brought to light in 1879 by an Austro-Hungarian diplomat, Major Friedrich von Pilat. The map, signed by Giovanni Leardo, the Venetian, and dated either 1452 or 1453, combines several unusual elements. A series of concentric circles forming a calendar of saints' days together with lunar and solar almanacs surrounds a circular disk on which are depicted lands and seas, rivers, mountains, and towns. Many place names drawn from various sources are of interest to students of the history of geography. In the general arrangement of the features shown and in the pleasing color schemes the map forms a work of art of no little decorative value.

A full-size colored reproduction of this map has been made for the Society by the firm of A. Hoen & Co., Baltimore, and is now ready for distribution. The reproduction is accompanied by a small illustrated book in which Dr. J. K. Wright, Librarian of the Society, explains the map. The book may be purchased separately by students who do not wish to buy the reproduction.

Distribution of Title Page, Contents, and Index of Volume 17 of the Geographical Review. The title page, table of contents, and index for Volume 17 of the *Geograph-*

ical Review (1927), which is issued separately, is ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

The Death of Professor William Libbey. Professor William Libbey, Councilor and Foreign Corresponding Secretary of the Society, died at his home in Princeton, N. J., on September 6, 1927, in his 73rd year. The Council at its monthly meeting of November 17 passed a resolution of sympathy thereon.

Dr. Libbey was professor emeritus of physical geography at Princeton University with which institution he had been long associated. For 40 years he acted as director of the museum of geology and archeology. In his student days he worked under Guyot, and his first contribution to the *Bulletin of the American Geographical Society* was an appreciation of "The Life and Scientific Work of Arnold Guyot" (Vol. 16, 1884, pp. 194–221). He also edited the revised edition (4th) of Guyot's "Tables, Meteorological and Physical" (*Smithsonian Misc. Colls. No. 538*), published in 1884.

In the summer of 1886, with Lieutenant Schwatka, Professor Libbey explored the country about Mt. St. Elias, of which he furnished an enthusiastic description, "Some of the Geographical Features of Southeastern Alaska," to the Society's *Bulletin* (Vol. 18, 1886, pp. 279–300). Twice he visited Greenland: on the first occasion as geographer of the Peary Auxiliary Expedition of 1894 commanded by Mr. Henry G. Bryant (see *Bull. Geogr. Club of Philadelphia*, Vol. 1, 1893–1895, pp. 141–215), and again in 1899 as leader of the Princeton Scientific party on the Peary Club's relief ship *Diana* (see *Bull. Amer. Geogr. Soc.*, Vol. 32, 1900, pp. 245–248). His chief expedition, however, was that to the Holy Land undertaken with Dr. F. E. Hoskins of the Beirut Mission in 1902. The narrative of the trip is given in two finely illustrated volumes "The Jordan Valley and Petra" (1905).

For several years Professor Libbey carried out oceanographical investigations off the New England coast for the U. S. Fish Commission, the major results of which are given in a report before the Sixth International Geographical Congress held in London, 1895 ("The Relations of the Gulf Stream and the Labrador Current"). It was in recognition of his work that Sir John Murray named one of the North Atlantic deeps off that coast the "Libbey Deep." Similarly in appreciation of seismic data collected by Professor Libbey, Milne named the "Libbey Circle," a circle which he describes as of radius 70° centered 180° longitude and 60° N. latitude (*Rept. British Assn. for the Advancement of Sci. for 1904*, p. 44), the median line of a great fracture zone.

Professor Libbey was an Officer d'Académie of France and a member of many learned institutions. He also devoted much time to patriotic and civic services.

GEOGRAPHICAL RECORD

NORTH AMERICA

Some Official Explorations in the Canadian Arctic Archipelago. The great unknown interior of Baffin Island has lately attracted official attention in Canada. In addition to the regular police patrols several scientific trips have been undertaken (see the Reports of the Royal Canadian Mounted Police for 1924–1925 and 1925–1926 and the Report of the Department of Mines for 1925–26). In July, 1924, Mr. J. D. Soper took up headquarters at Pangnirtung, the post on Cumberland Sound, to make natural history collections for the National Museum at Ottawa. The following April in company with a member of the patrol he set out for Lakes Nettilling (Netsalik) and Amadjuak, "said to be the nesting place of the blue goose," following the route traversed by Hantzsch in 1910. They proceeded up Nettilling Fiord, crossed the divide between Cumberland Sound and Foxe Basin, "rugged country with heights up to 5000 feet," to the eastern shore of Lake Nettilling. Here elevations were about 400 feet, the surface of the lake itself being about 85 feet. After the break-up of the ice in early August the southern shore of the lake was followed to the mouth of the Amadjuak River. West and north stretched a broad flat plain with "a large light colored hill on the horizon" (300 to 400 feet). In the vicinity were many ancient stone walls and tupik rings. The Eskimo apparently came here from the south coast for the summer caribou hunt. Few traces of caribou, however, were seen: Mr. Soper notes that enormous numbers have been killed off since the introduction of the rifle.

The western shore of the lake, low lying and fringed with gravel reefs thrown up by the ice, was followed to the mouth of the Koukjuak River, and this stream was descended for ten miles. The Koukjuak is described as shallow, one to three miles wide, and flowing with a current of three miles an hour over a limestone bed. The surrounding country is "flat and swampy, the beaches rich in fossils": to the north is a low range of hills. Caribou appeared more plentiful here. The return to Pangnirtung was made over the same route.

A communication from the Geological Survey of Canada gives a summary of Mr. Soper's work in 1926. He left Pangnirtung on January 9, and with two Eskimos crossed the interior of Baffin Island via Lake Nettilling to Foxe Basin, which was reached February 2. On the return trip he completed his map of the north side of the lake. He found the country west of Lake Nettilling and north of Koukjuak River very flat and destitute of game in winter. These surveys show that the lake is considerably smaller than previously indicated on maps and that the Foxe Basin coast lies at least 43 miles farther to the east than was formerly supposed. In March Mr. Soper made a 400-mile trip to Lake Nettilling to bring out the scientific collections of 1925 and to make a cache at the mouth of Amadjuak River. He left Pangnirtung again April 11 and traveled 380 miles by sled, reaching Amadjuak Bay April 26. On the way he visited the limestone escarpment on the west side of Amadjuak Lake. Part of this latter trip was over the course traversed by Major L. T. Burwash, exploratory engineer of Northwest Territories and Yukon branch in 1924, but some new mapping was done on the small lake system south of Amadjuak Lake. From Amadjuak Mr. Soper went to Cape Dorset, 125 miles. A report of Mr. Soper's work, with maps, is now in preparation.

Between February 15 and May 2 of 1926, two members of the police patrol made an overland trip 1300 miles in length from Pangnirtung to the new post at Lake Harbour on the southern coast. As far as the mouth of the Amadjuak River the route lay over the ground traversed by Mr. Soper the preceding year; thence it was up the river, a winding rapid stream averaging 200 feet in width. The course of this open water was visible from a long distance by the cloud of vapor rising from it. There are falls on the river just above the entrance to Lake Nettilling and again midway up the stream. Three prominent limestone cliffs or escarpments were noted as landmarks on the west side of Lake Amadjuak. Lake Mingo was passed, and high granite ranges were crossed to the coast. Serious errors were found in the delineation of the large lakes on the "Map of the Northwest Territories for 1924." The patrol observes that caribou cannot be depended on and comments on the fact that Dr. W. T. Lopp was spending the spring in the interior of the Amadjuak post region in search of feeding grounds for the Hudson Bay Reindeer Company. Of the herd of 550 reindeer landed at the post in 1921 not one animal survives.

In 1926 and 1927 Dr. L. J. Weeks, of the Canada Geological Survey, undertook an extensive mapping program in the northern portion of Cumberland Sound, carrying a traverse through a chain of small lakes to Lake Nettilling and along its southern shore. Publication of his maps will be awaited with interest.

Starting in February, 1927, Dr. L. D. Livingstone, medical officer in the Canadian Arctic Archipelago, made a 51-day trip from Pangnirtung, via Frobisher Bay and overland to Lake Harbour, then west 130 miles to Amadjuak, along the southern shore of the lake and by a new route following an uncharted river to Cumberland Sound (*Nat. Resources, Canada*, Oct. 1927). Shortly after his return he set out for Ponds Inlet, the post on the northern coast of Baffin Island. Near Ponds Inlet the coast was found to be badly charted. In the course of his patrols Dr. Livingstone made an estimate of the native population and gathered information on the living conditions. His report on their health and well being appears to be generally favorable.

Among other notable journeys accomplished in 1926 as part of the routine work of the police in the far north was a 900-mile patrol from Ponds Inlet to the eastern coast of Baffin Island (Home Bay), while the officer at Craig Harbour traveled to Axel Heiberg Island by way of Jones Sound and the west coast of Ellesmere Land, a total of 975 miles, in 40 days. In 1927 a 1320-mile patrol was made in 54 days from the new post at Bache, in latitude 79° N. (for an account of the post see "Canada's Arctic Islands: Canadian Expeditions 1922 and 1923, J. D. Craig, 1924, F. D. Henderson, 1925 and 1926, G. P. Mackenzie," Dept. of the Interior, Ottawa, 1927), to Axel Heiberg and other islands to the west. This journey was notable for the quantity of game encountered, especially musk oxen, and a discovery of coal on Bay Fiord.

Survey of Great Slave Lake Region. Recent surveys have made striking changes in the topographic map of the Great Slave Lake region of Canada. Although the route to the Arctic via Lake Athabaska, Great Slave Lake, and the Mackenzie River has long been traveled, knowledge of the country east of Great Slave Lake was, until recently, based chiefly on a map drawn from memory by Samuel Hearne who crossed it in 1772. Discovery of oil on the Mackenzie River led in 1921 to the first of a series of surveys in this region. A control party passed through Great Slave Lake and down the Mackenzie in that year.

In 1922 the east end of the lake was explored. Surveys on the North Arm in 1923 revealed several important portages to the Arctic. Early in the following year, work on the ice determined the positions of islands in Great Slave Lake itself; and later an examination was made of the lakes lying to the north of McLeod Bay. A pamphlet "Great Slave Lake Area, Northwest Territories," by G. H. Blanchet (Canada Dept. of the Interior, North West Territories and Yukon Branch, 1926), gives a general description of the country covered by these surveys and discusses the present condition of communication and settlement.

In 1925 the Taltson River and Nonacho Lake were surveyed, Nonacho Lake being considerably altered on the maps as a result. The upper Taltson River and Lake Eileen, probably the source of the Thelon River, were mapped; and a return to Great Slave Lake was made by the hitherto unexplored Snowdrift River (*Nat. Resources, Canada,* Feb., 1926, p. 3.) In 1926 the Abitau River, a newly discovered tributary of the Taltson-Tazin river system, was explored; and the Thele-aza River of Hearne's map was rediscovered and proved to be the headwaters of the Dubawnt River, rather than those of the Thelon River as had been supposed. (*Nat. Resources, Canada,* May 1927, p. 2.) Mr. G. H. Blanchet, who has been in charge of these surveys, describes his work of 1926 in the *Bulletin of the Geographical Society of Philadelphia* for October, 1927.

Rain-Bearing Winds in the Western United States. In view of their importance in connection with weather forecasting, and also in relation to climate, it is rather surprising that so little attention has been paid to the directions of rain-bearing winds in the United States. These directions depend upon the location of the source of water vapor; the nature of the intervening country; the cyclonic tracks; local topography; and other controls. In a recent number of the *Monthly Weather Review* (Vol. 55, 1927, pp. 228–233) Thomas R. Reed discusses "Rain-Bearing Winds in the Far Western States" and gives an interesting set of diagrams of rainfall percentages for each of the eight compass points, and for the various months of the year, at first-order Weather Bureau stations in the San Francisco forecast district. The data cover the ten-year period 1916–1925, except in the case of Spokane, where only a five-year record was available. There are 21 stations in all—in Washington, Oregon, California, Nevada, and Idaho.

The dry season rainfall is so infrequent over this great area that, with only ten years of record, the data for the dry months are not to be relied upon. The most striking fact in the tables and diagrams is the preponderance of precipitation with south winds. When the rain-bearing winds have other directions, the explanation is doubtless to be sought in topographic controls. Precipitation is infrequent with east winds, and when it occurs, as it does in some cases, the explanation is again doubtless topographic. Thus, at North Head and Portland, Ore., a small percentage of easterly rainy wind is probably connected with the proximity of the Columbia River gorge, which forms an east-west gap through the mountains.

At Los Angeles the winds from the ocean (S. W.) are not the rainy winds, but easterly and northeasterly winds bring rain in nearly all months and exceed other directions in rain frequency in the majority of cases. Similar conditions, although somewhat less marked, are seen at San Diego. Reed believes that this anomaly is probably due to "the formation of some sort of eddy conforming in a general way to the axes of the principal ranges." Two stations, Baker and Boise, also for local topographic reasons, have rain from north and northwest. In the Sacramento Valley there is comparatively little rain with northwest winds, which are downslope winds (Red Bluff and Sacramento), while in the San Joaquin Valley (Fresno and San Jose) northwest winds are upslope winds and bring a moderate proportion of moisture.

The generally meager rainfall with westerly surface winds, it is suggested, may be due to the fact that the wind aloft is usually northwest at those times. A northwest wind, aloft, would parallel many of the mountain ranges and reach others at a rather small angle. The opposite would be true of southerly winds. An examination of the isobaric charts for a wet and for a dry October in the far western states shows that for the former the trend of the isobars indicates a preponderance of southwest winds in the free air; while, for the dry month, winds from northerly quarters are indicated aloft. In the wet month the Pacific high-pressure system lay far to the west, and winds from the southwest (rainy) quarter had free access to the lower latitudes. In the dry month, the oceanic high pressure system had an abnormal position, its axis being prolonged in a northeasterly direction up the Pacific coast, implying a displacement of the southwesterly air currents into high latitudes.

R. DeC. Ward

EUROPE

The Decline of Transhumance in Rumania. Well down into the nineteenth century shepherds with their flocks from the commune of Sălişte, which lies on the north slope of the southern Carpathians, might be seen during the autumn and winter filing along the dusty roads of the Wallachian and Moldavian plains, or even crossing the broad steppes of the Dobruja beyond the Danube. In summer they would retire to the high mountain pastures. On the days of St. John (June 24), St. Peter (June 29), and St. Elias (July 21) a picturesque "festival of the heights" was held. "When the mountains were carpeted with flowers, on the clearings at certain summits . . . which form the meeting places of several pastoral regions, young and old would assemble from the *stâna* (chalets) of an entire mountain massif to pass the day in making each other's acquaintance, singing, dancing, offering libations, and even in exchanging merchandise and celebrating weddings."

This colorful shepherd life with its characteristic and highly developed practice of transhumance is on the decline throughout the southern Carpathian region. A variety of circumstances has brought this about, primarily: the occupation of the Wallachian plain by an agricultural population, an economic war between Austria-Hungary and Rumania (1886–1900), and the closing for a time of the Carpathian frontier. At present most of the "old shepherds of Sălişte, forced to sell their great flocks, have taken up itinerant or fixed trading, have established themselves in the towns of Wallachia, have bought or sold land in Dobruja, and have become artisans despite their former abhorrence of this occupation."

The pastoral life of Sălişte and of several neighboring communes is made the subject of a monograph by Nicholas Dragomir in the second volume of "Lucrările Institutului de Geografie al Universităţii din Cluj" (Travaux de l'Institut de Géographie de l'Université de Cluj (Roumanie)), pp. 193–257. The first volume of this series, which appeared in 1922, contained the published results of the geographical excursions conducted by Professor Emmanuel de Martonne in Rumania in the summer of 1921. Besides Dragomir's study, Volume 2 includes a group of papers on historical, human, regional, and physical geography which clearly show us that De Martonne's former pupil, Professor G. Vâlsan, has developed at the University of Cluj an institution where geographical research is being conducted in conformity with the fine traditions of the modern French school.

Movements of Population in Calabria. In the *Review* for October, 1927, Professor J. W. Goldthwait told the story of a New Hampshire town that has "gone downhill." He showed how the upland farms had been abandoned one after another during three quarters of a century, until by 1925 the "tide of humanity" had "drawn down to the 1100-foot contour, leaving" all above that level "a silent wilderness." Gradual displacements of long-established agricultural populations are also taking place in different parts of Europe. An interesting case of a downhill movement in the French Alps was recently discussed by D. Mouralis in the *Revue de Géographie Alpine* (Vol. 12, 1924, pp. 547–644; see *Geogr. Rev.*, Vol. 16, pp. 313–315). Similar movements in Calabria have of late been investigated by Salvatore Pagano, who presents his results in an article entitled "Qualche esempio di movimenti di popolazione in Calabria," in *L'Universo*, Vol. 8, 1927, pp. 939–960.

Pagano selected two regions for intensive study: a coastal tract along the Ionian Sea and the valley of the Marepotamo, a short stream which flows parallel to and not far to the west of the main axis of the Apennines. In the former region during past centuries fear of Saracen and Turkish pirates led to the abandonment of the coastal plain. The inhabitants retired to villages perched on the ridges that form the buttresses of the Apennine chain. Since the early nineteenth century, however, the population has gradually been returning to the coast, attracted by the superior agricultural opportunities afforded on the narrow strip of plain. In the present century the movement has been stimulated by a vigorous campaign waged by the government against malaria. As does Professor Goldthwait for the New Hampshire town, Pagano demonstrates some interesting correlations between the movement of population and the local topography.

In the Marepotamo valley two terraces intervene between the river and the main mountain ridge, the general altitude of the lower terrace being between 250 and 300 meters and that of the upper between 600 and 800 meters above sea level. In the eighteenth century a line of small villages fringed the edge of the lower terrace where it falls off into the gorge of the stream. Generally parallel with this fringe of small villages a line of larger villages followed the upper margin of the lower terrace. During the Napoleonic era brigandage and highway robbery were rife in Calabria. Fear of outlaws led to the abandonment of most of the small villages, their inhabitants retiring to the larger centers. Here they found the protection afforded by numbers and were less exposed to the malaria which lurks in the damp depths of the valley. Furthermore, the inhabitants of one of the abandoned villages moved to a wholly new settlement on the higher terrace. Mountaineers from the Apennines and settlers from the east of the range have also within the last forty years established a number of villages along the upper margin of the higher terrace, where the air is bracing and healthful, where the soil has not been exhausted by centuries of use, and where malaria is almost unknown. Thus in this part of Calabria the tide of settlement is actually flowing up the mountain side.

The Repopulation of the Roman Campagna. In the introduction to his book "The Roman Campagna in Classical Times" (London, 1927) Thomas Ashby points to the transformation now taking place in the countryside about Rome. As Sir Archibald Geikie noted in his essay on "The Roman Campagna" (Landscape in History, 1905) Rome has been unique among the great capital cities in that it stands in the midst of a wide solitude. Since the depopulation that set in with the fall of the Empire and which seems to have attained its worst stages in the seventeenth, eighteenth, and earlier half of the nineteenth centuries, the Campagna has been largely given over to sheep pasture and the temporary occupation of shepherds who come down from the Abruzzi hills in the winter. The woodland of the right bank of the Tiber also had its temporary immigrant occupants, woodcutters and charcoal burners, chiefly from Tuscany.

When Rome became capital of United Italy the population was about a quarter of a million. By the end of the nineteenth century it had approximately doubled, and today it is over 750,000, growing rapidly and spreading beyond the city walls. Malaria control has made possible the reoccupation of the Campagna, and agrarian improvement is playing its part. In the first years of the present century a law was passed to compel landowners in the Agro Romano—the territory of the commune outside of the city limits—within a radius of six miles of the city, to cultivate their land productively under penalty of expropriation. The recent introduction of motor plows and the growth of motor transportation have favored the movement. "Towards the Alban Hills especially there is now only a short interval—and in some places none at all—between the cultivation spreading outwards from Rome and that extending downwards from the hills. New farmhouses are springing up everywhere, and the aspect of the Campagna has completely changed. Whereas twenty years ago the road system resembled a starfish, the main roads being entirely unconnected, it is now more like a spider's web."

AFRICA

The Origin of the Nile Valley in Egypt. The traverse of Africa from Cairo to Victoria Nyanza made in 1926 by Professor A. C. Lawson, of the University of California, gave him opportunity to study the course of the Nile and to propose a new and ingenious explanation for its valley in Egypt (A. C. Lawson: The Valley of the Nile, *Univ. of California Chronicle*, Vol. 29, 1927, pp. 235–259). He recognizes six unlike sections in the 3500-mile length of the river: first, about 500 miles of alternating lakes and rapids below the outlet of Victoria Nyanza; second, 1100 miles of sluggish flow across a vast alluvial plain occupied in its south-central part by the vast papyrus swamp known as the Sudd; third, a great sigmoid double curve about 950 miles in length, at the beginning and end of which stand Khartoum and Wady Halfa where the river flows across a denuded area of crystalline rocks; fourth, a narrow, cliff-bounded canyon of normal erosion in Nubian sandstone; fifth, a cliff-walled trough in the younger limestones and sandstones overlying the Nubian sandstone; sixth, the deltaic course.

There has been much difference of opinion in the last 30 years concerning the origin of the fifth section of the river. Beadnell and Blanckenhorn have argued for down-faulting, while Ball and Hume have contended for river erosion. Lawson decides in favor of down-faulting, largely because he found tilted and depressed masses of the enclosing strata along the margins of the trough. Ball had taken these masses for landslides along the border of a valley of erosion; Lawson finds them too little shattered for landslides and therefore regards them as tilted fault blocks, to which he applies the name of "kernbuts" from his previous study of the geomorphology of a part of the High Sierra of California. The fault trough thus formed contains marine strata overlain by lacustrine deposits; and on these rest extensive detrital fans, washed into the trough from gorges in the enclosing walls and now more or less dissected. It is therefore concluded that, when the region stood lower than now, the down-faulted trough was first occupied by an arm of the sea, then by a body of fresh water; that it next, in consequence of regional elevation, became a dry desert depression, into which the detrital fans were washed by flooded wadies; all this before the Nile was led into the trough by flowing northward over the degraded area of crystalline rocks and across the belt of Nubian sandstone where its canyon is now eroded. Not till a relatively late date was the flood plain of the Nile and its delta extension, constituting the Egypt of history, formed within the trough with a northward fall of about six inches to a mile. The partial dissection of the marginal fans, on which the flood plain overlaps, is thought to have been prompted by the removal of the fan fronts by lateral river erosion. The delay in the arrival of the Nile is attributed to the total loss of its waters by evaporation in the initially much larger Sudd, where an enormous volume of local rainfall and river inflow is lost even today, but where enough now survives to maintain an overflow northward.

W. M. Davis

The Ancient Topography of the Faiyûm and the Problem of Lake Moeris. The most recent attempt to solve the problems raised by the accounts given by Herodotus and other ancient writers of Lake Moeris in the Faiyûm district of Egypt has been made by Georges Hug in "Le 'Moeris': Étude de géographie physique historique" (*Bull. Soc. Royale de Géogr. d'Égypte*, Vol. 15, 1927, pp. 1–44). His solution is based upon a personal study of the geology and topography of the Faiyûm and is an interpretation of the results of his observations in the light of generally accepted principles of shore-line development.

In general M. Hug's conclusions as to the history of the Faiyûm lake differ little from those set forth by the reviewer in the *Geographical Review* for July, 1926 (pp. 353 ff.) on the basis of the works of Brown, Beadnell, and others. In one point, however, there is a substantial conflict, namely in the level assigned to the historic Moeris and, consequently, its use as a artificial reservoir. Hug believes that the lake never stood for any length of time at a high level of 22 or 23 meters, with a low level of 17.5 meters, and holds that its southern beach, traceable in a sandy bar running from east to west across the province, indicates a high level of 18 and a low level of 16 meters. What Major Brown interpreted as an artificial dike constructed to hold a flood level of 22 meters in the lake, Hug shows to be a natural barrier beach, with an elevation of from 22 to 24 meters in its eastern and only 20 meters in its western part, produced during a period of temporary equilibrium between the water supply derived from the Nile and the process of evaporation. The colossi at Biahmu mentioned by Herodotus were erected under the Twelfth Dynasty subsequent to the formation of this barrier. Hence it seems logical to conclude that the lake had by that time sunk to the shore line of 18 meters. This level, the author thinks, is that of the Lake Moeris of Herodotus. If so, its level would be too low for it to serve as a reservoir with an outlet through the Bahr Yûsef gap. However, here one should take into account not the present level of El Lahûn, as Hug does, but the 18-meter rock barrier in the Bahr Yûsef.

The one serious difficulty with this theory is how to explain the maintenance of the 18-meter level from the nineteenth century to the fifth century before the Christian era when Herodotus visited Egypt. For in the course of the next two centuries the lake had sunk to sea level or below. The suggestion that Herodotus meant to say that the colossi stood "in the middle of the lake shore" instead of "in the middle of the lake" seems less plausible than that the historian saw them during flood time with an irrigation basin in front and the lake behind. Nor does Hug's view that the tradition of Lake Moeris as a reservoir is a dim remembrance of the prehistoric lake with its higher water level commend itself. It is much simpler to suppose regulators at Lahûn and Hawâra which closed the Bahr Yûsef when the arable land in the Faiyûm had been flooded and diverted the water from this canal into one leading north into the valley.

In a supplementary note Hug rejects, rightly I think, the theory of Petrie (*Journ. Royal Anthropol. Inst.*, Vol. 56, 1926, pp. 325–327), that Lake Moeris attained its maximum level (26 m.) in Ptolemaic times, and that of Miss E. W. Gardiner (*ibid.*, pp. 301–323), that there were two distinct lakes, the one prehistoric at a level of 23 meters and the other the historic Moeris which rose to 18 meters and then gradually subsided. Hug finds support for his own views in the careful topographical observations of Miss Gardiner on the northern side of the Birket Qarûn.

In "The Recent Geology of the Northern Fayum Desert" (*Geol. Mag.*, Vol. 64, 1927, pp. 386–410) Miss E. W. Gardiner gives a detailed report of her investigations into the question of the Faiyûm lake. On the basis of a careful examination of the most recent deposits—the lake beds—she reaches the following conclusions. Within Pleistocene times at least four distinct high lake levels are traceable. These are: (1) at 97–112 feet (over 30 meters) above sea level, not previously recorded and probably the earliest; (2) a 74-foot (23 m.) level which gradually sank until the lake to which it belonged completely, or very nearly, dried up; (3) a level of 57 feet (17.4 m.) belonging to a lake which appeared after the deposits of (2) had been hardened and eroded. When this lake in turn had begun to subside its shores were peopled by Neolithic flint users who certainly antedate the XIIth Dynasty; (4), a 12-foot (4.7 m.) level, representing a new lake, or a revival of the Neolithic lake belonging to the historic period. In conclusion, Miss Gardiner discusses Georges Hug's "*Le Moeris,*" signaling the points of agreement and disagreement between them and answering his criticisms. In particular she defends the prehistoric 74-foot lake, while agreeing that there was no historic lake at that level and that the supposed dike is a natural geological formation. Her opinion that the problem of the relationship of these several lakes, their age and duration, and their connection with climatic changes in other regions cannot be settled until the whole basin has been studied more adequately seems thoroughly sound.

A. E. R. Boak

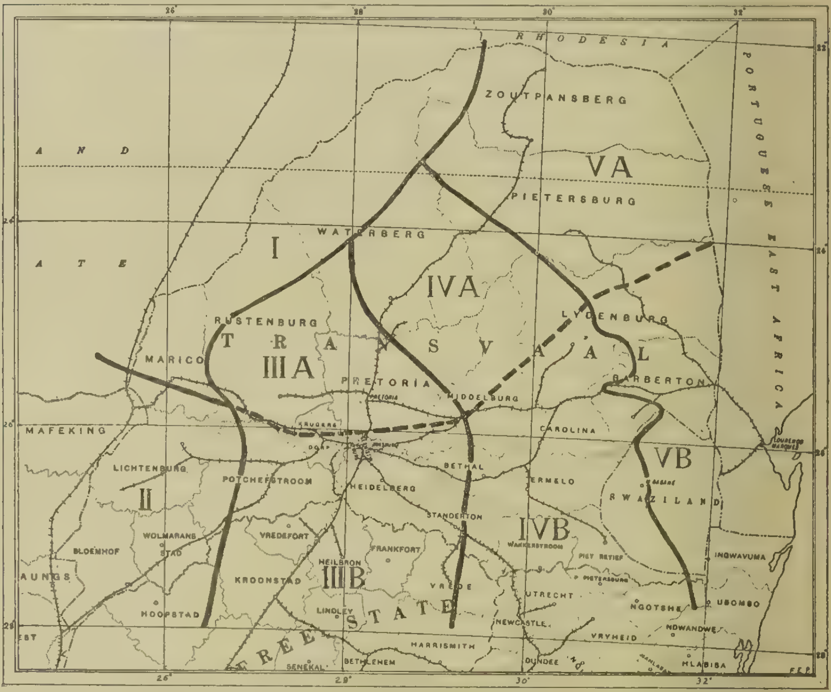

Fig. 1—Hyetal regions of the Transvaal. Reproduced from Map 17 of "Rainfall and Farming in the Transvaal." Scale approximately 1:8,500,000.

Agricultural Regions of the Transvaal. "The production from farming in South Africa is predominantly a moisture limited one" is the text of "Rainfall and Farming in the Transvaal" (*Transvaal Univ. College Bull. No. 12*, Pretoria, 1927). In Part I Professor F. E. Plummer gives the result of "A Preliminary Investigation into the Variability of the Rainfall in the Transvaal" (see also *South African Geogr. Journ.*, Vol. 9, 1926, pp. 5–20). His analysis is directed towards an appraisal of rainfall efficiency. Thus it is based on the hyetal year starting July 1, because 80 to 92 per cent of the annual rainfall occurs in the summer months, October to March. The general mean value of rainfall is relatively high, nearly 29 inches, but its "adequacy for agriculture is disappointing." As yet data for analysis are meager, and arithmetical means are inadequate where the rainfall approaches critical limits; years of abnormally high rainfall for instance exert an undue influence on the figure for the average. Professor Plummer considers the "most probable" means by the method of least squares. A series of maps illustrates his analysis and concludes with one of the "Hyetal Regions of the Transvaal," reproduced herewith. In broad outline it constitutes a land utilization map. A brief description of this map is given in Part II, "Rainfall in Relation to Agriculture in the Transvaal," by Professor H. D. Leppan.

Region I with low rainfall (20 inches), high evaporation coefficient, and extreme unreliability is a pastoral region of a ranching type. Though Region II has a still smaller rainfall, evaporation is lower, the land higher, and run-off smaller, and farming possibilities are better. The region is adapted to sheep as well as cattle. The agricultural economy of both Regions I and II will lie in the main in the breeding of animals to be fattened in regions of more assured fodder crops. Region III A with more rainfall is transitional in character. Maize and sorghum are successful most years on the better soils. Peanuts and cotton may be grown on rainfall alone; and tobacco, alfalfa, winter cereals, citrus fruits under irrigation. Proximity to mining and industrial regions will encourage diversified farming but the variation of the rainfall means a measure of instability. This disability has less weight in Region III B where the possibilities of diversified farming and high production over a large area are "scarcely paralleled anywhere else in South Africa." The length of the frost-free period, however, does not permit the cultivation of cotton and other subtropical crops.

Region IV A is a transition region like III A. Rain reliability is greater, but rugged topography encourages pastoral occupation. Region IV B enjoys the most effective rainfall of the Transvaal, but the smaller amount of sunshine from the center towards the east is less favorable to maize; on the other hand cool conditions in the higher portions permit the growth of oats and turnips.

Region V A exhibits wide differences in altitude and climate, but rainfall is generally unreliable. Except where irrigation is possible or the rainfall is over 35 inches arable farming must be attended by a large measure of uncertainty. The region includes much undeveloped land, which is offered at low prices. Professor Leppan points out that this unfortunately is likely to attract those least able to support the financial strain imposed by the erratic rainfall. Region V B is similar though less unreliable and possesses better possibilities of irrigation.

Water Supply Problems of Kenya Colony. Though Kenya Colony lies on the equator, much of it is poorly watered. Mr. A. D. Lewis, Director of Irrigation of the Union of South Africa, who has recently made an investigation into the water resources on behalf of the government of the colony, estimates that no less than 42 per cent of Kenya has less than 20 inches annual rainfall (Colony and Protectorate of Kenya: Report on Irrigation, Water Supplies for Stock, Water Law, Etc., London, 1925). This northeastern half of the colony is an extension of the Somaliland desert. With the exception of a few tribes along the Tana, Athi (Sabaki), and Uaso Nyiro Rivers and a few water holes a huge stretch is almost uninhabited. In the most arid section, between the Uaso Nyiro and the northeastern frontier, are certain features, wells, pits, cairns, and pools, that have been interpreted as the water engineering works of an ancient and numerous population when the country was more suitable for occupation (C. B. G. Watson: Wells, Cairns, and Rainpools in Kenya Colony, *Man*, March, 1927, pp. 50–52). From this point of view the region merits further study. Of more immediate practical importance, however, is the problem of that section of the colony having a rainfall of between 20 and 30 inches and comprising 30 per cent of the area. It includes the bulk of the Masai Reserve, parts of the Ukamba Reserve, and small European areas (see the map "The Colony and Protectorate of Kenya," by L. Carpenter, Statistical Officer of the Dept. of Agriculture, Kenya, 1924–1925).

Mr. Lewis considers that the possibilities of extensive irrigation schemes in Kenya are "exceedingly poor." From the Tana, the only important stream, some 150,000 acres might be irrigated, but most of this would be in the lower course of the river where the primitive character of the population would not warrant the undertaking. From the Athi and its tributaries the irrigation of 15,000 acres might be possible, from the Uaso Nyiro, 5000 acres; and in the Rift Valley, where the need is urgent, 2000 acres. It is pointed out, however, that there are enormous areas in the colony where the rainfall is sufficient for the practice of ordinary agriculture if care be taken to conserve soil moisture. Special attention is called to sisal production where water requirements are small. Sisal is grown successfully with a rainfall of under 30 inches while the water required for factory purposes for "2000 acres of sisal would barely suffice for the irrigation of 20 acres of ordinary crops."

On the other hand there appear to be reasonable prospects of increasing the water supply for stock requirements by boring over a large area. Connected with this is the administration's desire the better to control the nomadic tribes. The establishment of large water centers capable of maintaining 10,000 head of stock and equipped with schools and dairies has been suggested, but, as Mr. Lewis points out, there is grazing to be considered as well as water. Overgrazing would probably result, especially in times of drought. Then, if rains fell elsewhere the population would move away leaving the schools empty and the dairies unused and thus remain "almost as elusive as formerly in matters of control and supervision." He comes to the conclusion that initial experiments should be based on a herd not exceeding 500 head, a number that supports 25 persons on the average.

The Destruction of the Malagasy Forests. The seriousness of deforestation in Madagascar is the subject of a paper by Dr. H. Humbert, of the University of Algiers, who has lately been on a mission to the island (La disparition des forêts à Madagascar: Ses causes, ses conséquences, *Rev. Gén. des Sciences*, Vol. 37, 1927, pp. 325–336). The native cultivation, *tavy*, exploitation of the forest products by the whites, and prairie fires are the chief destructive agencies. The actual area of virgin forest remaining is not known; excluding the Euphorbia scrub forest of the arid south it may be estimated at between two million and three million hectares, between one-thirtieth and one-twentieth of the total area of the island. This forest is distinguished by its great variety of species, including many peculiar forms, and it does not reëstablish itself when once destroyed. Like Perrier de la Bâthie, the author of the important work "La végétation malgache" (discussed in the *Geogr. Rev.*, Vol. 12, 1922, pp. 496–498), Humbert makes a prime distinction between the autochtonous and the secondary vegetation, the latter distinguished by the small number of species and the frequent dominance of one or two forms.

In the more humid east the virgin forest is replaced by second-growth woodland, *savoka*. If periodic burning over is resorted to, the *savoka* passes over to prairie. In the regions with a pronounced dry season the passage from forest to grass is direct. The area of *savoka* is now greater than that of the virgin forest. Grassland, however, is the dominant formation, occupying about five-sixths of the island. On the central plateau, for instance, so few are the forest remnants that steppe was long considered the native vegetation, though this is disproved by the character of the surviving forest remnants and the floristic character of the grassland. Dr. Humbert urges a revision of methods of cultivation and exploitation and the immediate establishment of natural reservations as the only means of saving from complete extinction the island's unique flora and fauna, "the precious heritage of a long geological past." (See also his note "Sur la flore des Hautes-Montagnes de Madagascar" in the *Compte Rendu Sommaire des Séances de la Soc. de Biogéogr.*, No. 31, 1927.)

Methods of native cultivation broadly similar to this robber economy of Madagascar are known elsewhere, but an argument against universal condemnation of such ways on superficial appearances alone is advanced by Father Hyacinthe Vanderyst in a paper "Géo-botanique agronomique comparée: La destruction des forêts à Madagascar et leur non-destruction au Congo par les pratiques culturales indigènes" (*Congo et Bull. Soc. Belge d'Études Colon.*, Vol. 2, 1927, pp. 1–14). He stoutly maintains that the *masole* system of forest clearing, a cultivation practiced by the Congo natives, is not attended by evil consequences. Father Vanderyst has had twenty years' experience in the Kwango region, and he rightly points out the differences in the native vegetation of the two countries. He asserts that the Congo vegetation can for the most part reëstablish itself and says that destruction by bush fires is unknown in the Congo. A contrary view, however, is expressed by É. de Wildeman, director of the Botanical Garden of Brussels, who refers to fire on the lower Congo as an agent in transforming the country "geo-botanically and orographically" and pleads for natural reservations in the Congo for the conservation of plants of scientific and economic interest (Considérations sur l'état actuel des connaissances relatives à la géo-botanique du Congo Belge, *Congo: Rev. Gén. de la Colonie Belge,* 6th year, 1925, Vol. 1, pp. 715–734; Vol. 2, pp. 13–36).

AUSTRALASIA AND OCEANIA

Early Maori Agriculture in New Zealand. Changes in their natural environment forced the Maori who settled in New Zealand to become a far more industrious people than they had ever been during their residence in Polynesia. Coming from semi-tropical islands where slight efforts at cultivation had resulted in large food returns, they found themselves in a country where a comparatively harsh climate forced them to devote most of their time to the collection of food. As the aborigines of New Zealand did not cultivate the soil, the Maori, although essentially an agricultural people, were forced to exist for a while on a scale of culture lower than that to which they had attained before their immigration. Hunting and fishing furnished important means of livelihood; and the fern root, a food plant new to the Maori, became of such consequence that a myth grew up regarding its origin. Attempts to introduce domesticated plants from the Polynesian Islands were only partially successful. By increasing their efforts the Maori were able to raise some of their more important foods in favorable locations. A system of barter grew up between the agricultural districts and those regions where hunting and fishing still supplied the principal means of sustenance.

The Maori settlers of New Zealand took many precautions in growing the *kumara,* or sweet potato—the most important of their cultivated plants. They selected sheltered spots, heaped fine gravel about each plant to insure perfect drainage, constructed fences and windbreaks, and provided fertilizer in the form of wood ashes. Cultivation was generally accomplished by a *ko,* merely a sharpened stick with a rudely constructed crossbar. Agriculture was regarded as a communal affair, participated in by all the people and accompanied by much ceremony. Considerable time and labor must have been expended on the well-kept plantations which have been described by Captain Cook and subsequent voyagers. In "Maori Agriculture" (*New Zealand Dominion Museum Bull. No. 9,* Wellington, 1925) Elsdon Best has compiled a quantity of material on "The Cultivated Food Plants of the Natives of New Zealand, with some Account of Native Methods of Agriculture, its Ritual and Origin Myths."

HISTORICAL GEOGRAPHY AND HISTORY OF GEOGRAPHY

Geography of the Odyssey. Where lay the islands and coasts which Odysseus visited? Among the German scholars who have been trying of late to answer this perplexing question some would restrict the Odyssean wanderings to the Mediterranean; others would carry them far out into the Atlantic. In the first group belongs Albert Herrmann, whose paper on Homeric geography was discussed in the *Geographical Review,* Vol. 16, 1926, pp. 670–671. The second group is represented, among others, by Adolf Schulten (see his "Tartessos," 1922) and by Richard Hennig, both of whom maintain that through contacts with the Phoenicians the Hellenes of the Homeric age acquired knowledge of the western ocean and that this knowledge was reflected in the epos.

In a volume entitled "Von rätselhaften Ländern," Munich, 1925, and in subsequent papers Hennig discusses various phases of the problem ("Das Weltbild Homers," *Zeiten und Völker*, Vol. 22, 1926, pp. 274–278; "Neue Betrachtungen zur Geographie Homers," *Geogr. Zeitschr.*, Vol. 32, 1926, pp. 290–296; "Grundsätzliche Bemerkungen zur 'Geographie Homers'," *ibid.*, Vol. 33, 1927, pp. 22–34; "Die Frage des Lästrygonen- und Kimmerierlandes," *Petermanns Mitt.*, Vol. 72, 1926, pp. 164–166.) He points out that many students of Homeric geography through exclusive preoccupation with philological and archeological evidence have acquired what he believes to be an absurdly limited view of the range of Homeric knowledge, particularly towards the west. To these scholars the western Mediterranean—even Italy and Sicily—lay on the edges of the known world of Homer's time. The opposite extreme of opinion is represented by one over ingenious but uncritical writer, who goes so far as to suggest that Odysseus actually entered the north polar regions; or by another enthusiast who argues that the wanderers reached the southernmost tip of Africa. As compared with these flights, Hennig's own interpretation of Odysseus' route is conservative, even though it might seem radical to the more old-fashioned classicists. He identifies the Cimmerians with the Kymri of Cornwall, placing the entrance to Hades in their country. He locates Scheria, or the land of the Phaeacians, at Tartessus in southwestern Spain and the Island of Ogygia in the Canaries.

Ogygia was the Island of Calypso, daughter of Atlas, "who knows the depths of every sea, and himself upholds the tall pillars which keep earth and sky asunder." (Odyssey, I, 53–54; S. H. Butcher and A. Lang's transl., p. 3). These pillars of Atlas have almost universally been associated with the Pillars of Hercules on either side of the Strait of Gibraltar. Hennig believes it more reasonable to identify them with the far more impressive Peak of Teneriffe. Indeed, the term "Pillars of Hercules," he maintains, did not come to signify the mountains of Calpe and Abyla overlooking the strait until as late as the fifth century, when the strait was closed by the Carthaginians (see Hennig's "Zum Verständnis des Begriffs 'Säulen' in der antiken Geographie," *Petermanns Mitt.*, Vol. 73, 1927, pp. 80–87. See also, however, Adolf Schulten, "Die Säulen des Herakles," in O. Jessen's "Die Strasse von Gibraltar," Berlin, 1927, pp. 174–206, especially p. 176, note 4; *Geogr. Rev.*, Vol. 17, 1927, pp. 505–506.) The lands of the Lotus Eaters, Cyclopes, and Laestrygons Hennig places on the coasts of the Mediterranean in what are now Libya and Tunisia.

Of the land of the cannibal Laestrygons Homer said: "There might a sleepless man have earned a double wage, the one as a neatherd, the other shepherding white flocks: so near are the outgoings [κέλευθοι] of night and day" (Odyssey, X, 83–86; Butcher and Lang's transl., p. 156). This passage has given rise to theories which have interpreted the κέλευθοι (usually translated as "paths") of night and day as referring in some way to the relations of day to night at high latitudes. Hennig believes that κέλευθοι means, rather, "pastures" and that the passage as a whole is more probably an echo of travelers' reports describing African peoples, such as those mentioned by Varro, who pasture sheep by day and neat cattle by night in order that the latter may avoid the tsetse fly.

In view of the vagueness of the Odyssey itself and the fragmentary character of our historical knowledge of the Homeric period, these problems, like that of Atlantis, are hardly as yet susceptible of definite settlement. The attempts that are being made to interpret the poems in the light of their cultural and geographical environment, however, are not without popular interest and scientific value.

Medieval Transportation and Travel. In the October, 1926, number of the periodical of the recently organized Mediaeval Academy of America published at Cambridge, Mass., Professor J. F. Willard contributes a short, scholarly article on "Inland Transportation in England During the Fourteenth Century" (*Speculum: A Journal of Mediaeval Studies*, Vol. 1, pp. 361–374). This subject was neglected by J. J. Jusserand in his "English Wayfaring Life in the Middle Ages" (London, 1889; N. Y., 1920) in so far as the "transportation of goods by land and water" is concerned. It seems that carts were used more than pack animals in the fourteenth century. Some idea of the speed of cart travel may be derived from these data: "two carts with victuals for the army made the journey from Malmsbury, in Wiltshire, to Carlisle in twelve days. . . . It took a cart with five horses eight days to go from Gloucester to London and return"; the journey from Lincoln to the Tower of London was made in nine days, as was that from Westminster to York. Pack horses were employed for light local transport, as well as "at or near the seacoast for the carriage of fish" and "to carry treasure or money across country in baskets or packs." Professor Willard's general conclusion is that "the roads of the fourteenth century were not quite so bad as they are often pictured, and that heavy carts moved over them at a reasonable speed. What is more, the transportation of goods was to a high degree free from danger. On every stream of fair size there were boats; on every road there were carts and pack-horses. The most vivid impression is that of the large amount of movement along the roads and streams, and with it the lack of isolation of mediaeval towns and villages."

In the same number of *Speculum* (pp. 375–397) Professor A. S. Cook discusses what little is known of the details of the famous journey of Augustine to England in 596—in its time a long and arduous undertaking. Professor Cook's article brings together incidentally not a little interesting material on land and water travel in the early Middle Ages.

Publication of the La Vérendrye Documents. In a note which appeared in the *Geographical Review*, Vol. 6, 1918, pp. 283–284, attention was called to the sensational finding at Pierre, S. Dak., in 1913 of "a lead plate deposited in 1743 by the sons of the intrepid explorer, the Sieur de Verendrye." In the same note the search by the La Vérendryes for the "Western Sea" and their possible discovery of the Rocky Mountains were discussed. During the last year, as one of the excellent *Publications of the Champlain Society*, Lawrence J. Burpee has edited, with English translations, notes, and an introduction, the *Journals and Letters of Pierre Gaultier de Varennes de la Vérendrye and his Sons: With Correspondence Between the Governors of Canada and the French Court, Touching the Search for the Western Sea* (Toronto, 1927). Mr. Burpee offers no new evidence in regard to the route of the younger La Vérendryes. After explaining various theories that have been put forward, he reaches the following conclusion: "On the whole, it would seem that the best case is made out" by Doane Robinson, who contends that the mountains sighted were the Black Hills rather than the main range of the Rockies—though this view "leaves the exploration of no very striking importance."

Such a judgment, relating only to the particular expedition of 1742–1743, should not blind us against recognizing the importance of the explorations of the La Vérendryes, as a whole. To them still belongs the major credit for opening up vast regions west and northwest of Lake Superior. They were undoubtedly the first white men to see the waters of Lakes Winnipegosis and Manitoba, to follow up the Saskatchewan River as far as its forks, and to visit the settlements of the interesting non-nomadic Indians of the Missouri, whether or not these were the Mandans. It is also probable that the senior La Vérendrye was the discoverer of Lake Winnipeg. His place, with that of his sons, in the history of the exploration of the heart of North America is secure.

OBITUARY

David George Hogarth. In the premature death of Dr. D. G. Hogarth at Oxford on November 6, 1927, in his 66th year, science has suffered a grievous and irreparable loss. At a time when Great Britain never was in sorer need of statesmanlike scientists with vision and administrative ability, there was no man in the whole range of archeological activity who could so ill be spared. While the loss to science is severe, the loss to his friends is even more grievous. In a long experience with men of his type, I have never met another who combined in so high a degree scientific ability and personal charm.

Hogarth possessed the confidence of the British Government, and I might say of all governments having anything to do with the Near East, to an extent perhaps unequaled by any other scientific man and certainly by no other man of science at work in the Near East. It is not generally known that one of Hogarth's greatest services to science was lost to the world through the dilatoriness of the Lloyd-George régime in dealing with the Turks after the triumph of the allies, a policy which was as costly to science in the territory of the former Ottoman Empire as it has also been in Egypt. A group of American archeologists, among whom the lamented Howard Crosby Butler was prominent, drew up a set of conditions which for the first time in history would have ensured to science the right to carry on scientific investigation throughout the territory of the former Ottoman Empire. When these conditions were placed before the Peace Commissioners assembled in Paris, it was the influence of Hogarth, officially representing Great Britain, which had more to do with convincing the Commissioners of the wisdom of the proposed provisions than that of any other representative. The stipulations were incorporated in the Treaty of Sèvres, but they were unhappily not carried over into the Treaty of Lausanne. It was in such situations that a scholar-statesman like Hogarth was able to render services of incalculable value to science.

Among his many admirable qualities the wide scope of his outlook is most conspicuous. Born and bred in a country parsonage, he always carried with him, whether at school in Winchester or afterward at Oxford, those fine traditions of an English clergyman's home that have given to the British Empire so many men of achievement. During a brilliant career as an undergraduate at Oxford he did not specialize in the lines of study in which he later gained distinction. At the age of thirty-one, however, he was appointed a "Research Fellow" with opportunities of travel in the lands of the Near East. Then began his highly varied activities in these regions. As Director of the British School of Archeology at Athens and Director of the Cretan Exploration Fund he rapidly made his place as a great British archeologist. For twenty years he was tireless in his explorations, especially at Ephesus in Asia Minor, at Carchemish in Syria, in Cyprus, in Egypt, and in Arabia. He was greatly interested in the Hittites, made himself master of the archeological problems in this field, and applied his mind with great penetration to disengaging the various subvarieties and differing cultural areas that had hitherto borne the name Hittite without proper differentiation.

The writer recalls among the pleasantest memories of his life the privilege of receiving Hogarth as a guest when the great archeologist was lecturing in America for the last time. A lecturer of singular charm, his addresses on the civilization of the Hittites drew large audiences. He was equally attractive as a writer; and many a reader who might never have known the delights of archeological and geographical explorations has made their acquaintance in Hogarth's beguiling volume, "A Wandering Scholar in the Levant." He turned aside from such studies long enough to write a life of Alexander and his father, Philip of Macedon; but it was exploration that especially attracted him, and although he never equipped himself as an Orientalist or an Arabist, philologically speaking, he was deeply interested in Arabia. His Arabian studies are among his most useful books.

With Hogarth archeology and exploration were always inseparable, and with his wide knowledge of the ancient classical sources he gradually became a geographer. He made his first visit to the Near East in 1887, in company with Sir William Ramsay, and wandered through Asia Minor with that great scholar. In the intimate details of local topography his contributions to geography have been most valuable; while his breadth of view appears characteristically in that excellent regional study

"The Nearer East." In 1917 the Royal Geographical Society awarded him their Founder's Medal, one of the highest distinctions within the reach of a geographer, and in 1925 he was elected President of the Royal Geographical Society. His third term had just begun, and he was about to preside at the first of its winter sessions when the end came.

Hogarth's wide knowledge of the Near East naturally made him of great value to his country during the war, and he was the obvious selection when the Government was looking about for a director of the Arab Bureau at Cairo. It was under Hogarth also that Lawrence, one of the most valuable servants of the British Government in the Near East during the Great War, received his training, especially during Hogarth's excavations at ancient Carchemish, on the fringes of the Syrian Desert, where Lawrence met many Arabs.

Not the least of Hogarth's services has been his administration of the Ashmolean Museum at Oxford, where he had been Director for nearly twenty years since the retirement of Sir Arthur Evans in 1908. This important post he was still occupying at the time of his death, and here his loss will be immediately and more directly felt; but his many-sided interests, his fine judgment, and his statesmanlike vision will be sorely missed throughout the whole range of scientific research in the Near East.

James H. Breasted

GEOGRAPHICAL REVIEWS

An Analysis of Early European Colonization in America

Georg Friederici. **Der Charakter der Entdeckung und Eroberung Amerikas durch die Europäer: Einleitung zur Geschichte der Besiedlung Amerikas durch die Völker der Alten Welt.** Vol. 1, xiii and 579 pp. (Allgemeine Staatengeschichte: Geschichte der Aussereuropäischen Staaten.) Friedrich Andreas Perthes, Stuttgart-Gotha, 1925. 9 x 6 inches.

Friederici's volume is a product of German scholarship at its best. The love for detail, the boundless curiosity regarding facts, the passion for following every subject into all of its ramifications are here happily combined with a lucid style and with skill in marshaling details to illustrate original ideas. As the title implies, the book is not a narrative history but an analysis and comparison of conditions and movements.

The volume is divided into three parts. In the first "the scenes of colonization" (die Kolonisationsschauplätze) and in the second the aboriginal inhabitants are discussed, these two parts covering the whole of America. The third part is devoted to the Spanish explorers and conquerers. Presumably the colonization of the present territory of the United States and Canada will be made the subject of a future volume or volumes.

In treating the scenes of colonization the author endeavors to reconstruct not only the natural environment as it existed during the great Age of Discovery but also the means of transportation and communication developed by the Indians at the time of the arrival of the Europeans. Innumerable passages and stray remarks in the writings of soldiers, travelers, and historians are correlated with the results of modern scientific research. The ways in which the differing environmental circumstances from region to region helped or hindered the progress of exploration, conquest, and settlement are suggested and compared. For example, Friederici finds an explanation of the very divergent histories of the Guianas and Venezuela in divergent geographical conditions. Although in climate and position these two regions have much in common, the shore line of the Guianas consists of a low alluvial plain whereas that of Venezuela is fringed by mountains. "While Venezuela invited colonization through its many superb harbors and its fruitful coastal fringe, Guiana's alluvial mangrove-covered shore repelled it. The latter was neglected by the Spaniards, who had at their disposal so much better land, and at an early date fell into the hands of their rivals, the Dutch and French, and later the English."

Friederici lays a great deal of stress on the part played by the Indians in facilitating the advance of the white man. Indian trails offered routes through forest, brush, and desert; Indian bridges spanned many a stream. A magnificent network of roads bound together the empire of the Incas. In regard to bridge building, the aborigines of America were far in advance of the primitive "Indo-Germanic" folk. "On a march of only about 170 kilometers from Orsza to Smolensk, King Sigismund I of Poland [1506–1548] was obliged to throw 340 bridges across swamps, ponds, and brooks. How different was the experience of De Soto in the territory of the present United States!" The geographical knowledge and sense of direction possessed by the Indians were also frequently of service to the early travelers. Friederici devotes no less than six pages to a discussion of Indian maps, citing cases where such maps are known to have been used by explorers.

The third part of the volume is itself divided into three chapters. Of these the first, devoted to the character of the discovery and "unveiling" (Entschleierung) of the coasts of America by the Spaniards, is a truly masterful analysis of the historical, geographical, and nautical background of Spanish marine exploration. Friederici speaks of the superlative greatness of Columbus as manifested not only in the first voyage but in the three that followed. Each "marked an epoch, each determined the general direction that subsequent exploring expeditions were destined to pursue for years to come." In the *expediciones á descubrir* sent out by the Casa de Contratación the author sees predecessors of the maritime scientific expeditions of the late eighteenth century, arguing, hence, that Oscar Peschel is unjustified in claiming that Dampier's voyage of 1699 was the first undertaking of this sort. The Spaniards, indeed, would seem to have been far in advance of their contemporaries in the matter of organized scientific exploration. In the final chapter of Part III, on the technique of the "Conquista," it is explained that "the very first thing that the Spaniards undertook to do in a hitherto unknown country was to carry out a thoroughly businesslike and far-reaching examination of the entire region in order to learn . . . the *secretos de la tierra*," these, of course, being primarily "precious metals, precious stones, pearls, and buried treasure in temples and graves." Strict governmental regulations controlled the gathering and compilation of the data, which thereby acquired a high scientific value and were ultimately made available to the "cosmographers and chroniclers of the Crown."

We await eagerly the subsequent volumes of Friederici's stimulating work. The work as a whole certainly ought to be translated into English.

Reflections of the Prairie in Literature

D. A. Dondore. **The Prairie and the Making of Middle America: Four Centuries of Description.** xiii and 472 pp.; ills., bibliogr., index. The Torch Press, Cedar Rapids, Iowa, 1926. $4.50. 8½ x 6 inches.

"Professor Turner and his followers have demonstrated convincingly to us the significance of the Frontier in American history; its influence on literature has never been determined." Thus Miss Donore suggests her purpose. The present volume is the first of a series in which she plans to consider the influence upon literature not only of the prairie but of the "Forest, . . . the Plains, the Mountains, and the Sea."

The Mississippi Valley has been the source of an immense and varied outflow of expression in print since the days when Cabeza de Vaca "first wrote an account of the bison and the great plains, . . . first crossed the continent from coast to coast." Down the whole course of this vast literary river, the varying currents and eddies of which Miss Donore surveys, two broad tendencies have been evident: that of the realists and that of the more imaginative writers who see the prairie through a purple haze of romance. As between these two groups form is not necessarily the determining factor. The realists, particularly those of the nineteenth and twentieth centuries, have often chosen the novel or poem rather than the more sober book of travel as their artistic medium.

To the French and Spaniards of the seventeenth and eighteenth centuries Miss Donore ascribes the "establishment of the romantic tradition" of the prairie. "The great inland valley that they discovered and explored was a world with the freshness of the dawn upon it, dewy sweet, exceptionally fertile, its bison-pasturing meadows, its dense forests, its placid waterways offering an idyllic background, fascinating vistas for adventure." This concept was taken over by later Anglo-Saxon romanticists and was carried even beyond the limits of the English tongue. "Probably not one of the literatures of Europe was left untouched by the influence of the new continent." "The advance line of civilization, moving across America as it moved across the fens and forests of the old world, for a couple of centuries lodged in the Mississippi Valley. And in turn the Valley's most distinctive features, the Prairies, together with the forests and rivers and the life they produced formed a distinct thread in the romantic literature of America and Europe. They with the rest of the frontier created a new and rich storehouse of materials for literary interpretation."

The prairie was preëminently the home of that fanciful creation of the philosophers of the *ancien régime* in France, the noble savage, whose virtue so eminently excelled that of the effete and corrupt European (see *Geogr. Rev.*, Vol. 16, 1926, pp. 671–672). But when it grew all to obvious that many of the Indians with whom the French actually came into contact had suffered terribly as a result of "the smallpox and strong drink" which these contacts had brought to them and were "living as down-at-the-heel neighbors of the whites . . . nothing was easier than to transfer to the Creoles the idyllic traits that had been in the making since the era of discovery; the cult of the native had become the cult of the habitant."

Miss Donore, discussing the development of romantic and realistic treatments in separate chapters, carries her survey down to contemporary times, long after the frontier had passed across and beyond the prairie. She even takes into consideration the city life of the Middle West, more particularly that of Chicago, as it figures in literature. Her book is a welcome contribution not only to the literary history but to historical geography, inasmuch as it traces the development of relations that have existed between a distinctive geographical region and one of the most important of all of the activities of the human mind (see also *Geogr. Rev.*, Vol. 14, 1924, pp. 659–660).

FIFTY YEARS OF CHANGE IN NEW ENGLAND

D. C. BREWER. **The Conquest of New England by the Immigrant.** vi and 369 pp. G. P. Putnam's Sons, New York and London, 1926. $2.00. 7½ x 5½ inches.

This story of Mr. Brewer's is not a new one. His contribution is largely in the forceful marshaling of the facts and in the trenchant manner of presenting them. The argument is well outlined in the headings of the five parts of the book: New England As It Was and Is; The Making of the Yankee; Expansion and Deterioration; Invasion; and Conquest.

The indictment against New England is severe. To use the author's phrase the New Englander is accused of scuttling the craft which carried their promising fortunes—not the original founders of New England but the sons of the first manufacturers who with a desire for wealth enlarged the village mills many fold and to man them became the advocates and instruments of easy and unrestricted immigration. The resultant in figures is fairly well known and after a fashion appreciated; at the same time it is an appalling condition. Smith in his "North America" states that one can hear every language save English on Boston Common; that a visitor at the City Hall in Woonsocket, R. I., heard no English except what was addressed to him; and Brewer adds to these hyperboles another—"unless we bid farewell to the new Boston, . . . we shall need an interpreter to get us out of the Hub."

Mr. Brewer would be the last man to place the entire blame for the present plight of New England on New Englanders alone. His earlier book, "The Perils of the Republic," shows him to be a deep student of the immigration question as it affects the entire country. The book under review, then, is only a section of his charge against the country as a whole for its immigration policy. The manufacturing elements have been the benefactors of open immigration at the expense of other industries and other occupations; and in this New England, especially southern New England, has had a large part.

But although the manufacturer benefited by opening the doors to the people of Europe, the country as a whole was not hostile to this plan, and there was a rather general agreement among nearly all classes to it. It was the age of the "melting pot" idea. This dream, now generally admitted to have been on the wholesale plan at least a mistake, was a potent argument for immigration.

With restricted immigration possibly some of the forebodings of this book may not be realized, and possibly New England may regain her former culture. Then, again, one must wonder what New England's destiny under the former régime was. Her soil was inhospitable and her sons were peopling the West. Even today her manufacturing supremacy is contested. But whether or not New Englanders accept the flagellations of Mr. Brewer, it will do them a world of good to read and ponder upon this presentation.

Robert M. Brown

Pioneer Communications in the American West

L. R. Hafen. **The Overland Mail, 1849-1869: Promoter of Settlement, Precursor of Railroads.** 361 pp.; map, ills., bibliogr., index. The Arthur H. Clark Company, Cleveland, 1926. $6.00. 9½ x 6½ inches.

Dr. Hafen has given us primarily an historical account of the development and expansion of the overland mail in the Trans-Mississippi country. The geographer, however, can glean much of interest in regard to the layout of the various routes, the effects of various environmental obstacles, the importance of minerals and other natural resources, and the like.

As a background to the main topic of the overland mail there is given a résumé of the postal service and routes during Colonial times in the east and a discussion of the development of the ocean mail routes to the Pacific coast by way of Central America (1848–58). Routes were established at the three most feasible constrictions in Middle America: first across the Isthmus at Panama, then a rival route across at Nicaragua, and finally by the Gadsden Treaty a route across at Tehuantepec (1853). The early development of these sea routes to California is evidence that an overland mail, though shorter, had many more natural obstacles to overcome.

The earliest overland mail carriers in the Trans-Mississippi region were almost invariably either military couriers or private stages and express lines. The first regular mail contract was from Independence, Mo., to the Salt Lake "oasis," following the line of the Oregon Trail up the Platte and over South Pass. A complementary route was early established from California to Utah. For all practical purposes these two came to be a through route. In summer it was a short and very feasible route; but in winter snows seriously impeded travel across the Rockies, and heavier snows often suspended travel across the Sierra Nevada passes. This climatic factor as well as political interests directed the next expansion of the overland mail routes farther to the south. Lines were extended from Independence to Santa Fe and from San Antonio to Santa Fe. This movement culminated in the establishment of the famous Butterfield Overland Mail, which, until the outbreak of the Civil War, rendered superior service at all seasons, the stages making the through trip to California by way of Yuma in 20 to 23 days. There also was a line established somewhat farther to the north from Kansas City to Stockton, which however was rather unsuccessful. Following this period of rather rapid expansion a policy of retrenchment was put into effect by an administration which frowned upon the policy of the Post Office Department as a pioneering agency (1859–60). Service was cut down on all lines except the Butterfield route in an attempt to put the business on a paying basis.

The author seems to know his ground especially well when treating of the development of express and mail routes to the Pikes Peak region, across that great triangle of territory lying between the old Santa Fe and Oregon trails and the Rockies of Colorado. Gold drew people to this region, mining towns sprang up in and near the mountains, for which Denver City became the supply center. The crying need for transportation with the outside world resulted in the establishment of the Leavenworth and Pike's Peak Express, a highly successful private enterprise.

Undoubtedly the most picturesque incident of the whole history of the overland mail was another private enterprise, the Pony Express. The fast and efficient riders demonstrated that the short central route was feasible and that obstacles could be overcome. The Pony Express was essentially supplementary to the rapidly expanding transcontinental telegraph line, gradually becoming shorter and shorter until the completion of the latter in 1861. When first established the advertised time by letter and wire from San Francisco to New York was nine days. The culminating phase of the overland mail was the establishment of a daily stage service over the central route, the "Million Dollar Mail" (1861–62). The development of other tributary routes went on apace, including lines to Denver and to the mining settlements in Montana in the Three Forks region. The inauguration of the transcontinental railroad over the central route brought about the gradual abolishment of the main stage line.

The book is a scholarly piece of research, and the flavor of the West has not been entirely buried beneath statistics. A geographer might well feel that the various descriptions of routes should be accompanied by sectional maps on a scale larger than the one folding map. The book is logically and simply organized, and the thesis is carried through, namely, that the overland mail, following in the wake of the first settlers, was in turn a promoter of settlement and a forerunner of the railroad. At least the book will prove a good antidote to geographic determinism.

ERIC P. JACKSON

PHYSICAL AND GENERAL DESCRIPTIONS OF ICELAND

THORVALDUR THORODDSEN. **Die Geschichte der isländischen Vulkane (nach einem hinterlassenen Manuskript).** 458 pp.; maps, ills. *Mémoires Acad. Royale des Sci. et des Lettres de Danemark, Sect. des Sci.*, Ser. 8, Vol. 9, Copenhagen, 1925.

ADRIAN MOHR. **Was ich in Island sah: Plaudereien vom Polarkreis.** 238 pp.; map, diagrs., ills. Otto Uhlmann, Berlin, 1925. 10 M. 9½ x 7 inches.

HEINRICH ERKES: **Neue geographische Forschungen auf Island.** Maps. *Mitt. Vereins für Erdkunde zu Dresden*, Vol. 3, 1925, No. 5–6, pp. 3–53.

THORSTEINN THORSTEINSSON, edit. **Iceland: A Handbook Published on the Fortieth Anniversary of the Landsbanki Íslands (National Bank of Iceland).** 184 pp.; ills., bibliogr., index. Prentsmidjan Gutenberg, Reykjavík, 1926. 8 x 5 inches.

In 1882, at the time when he was beginning the explorations of his native land, Dr. Thoroddsen issued in Danish a volume of some 170 pages, containing a historical survey of the Icelandic volcanoes; this was later translated, in a condensed form, into English by George H. Boehmer and published in the Smithsonian Report for 1885. During the intervening years between the appearance of that survey and the writing of this history of the Icelandic volcanoes here under review, the author had opportunity not only to discover new written sources in various libraries and archives but also to travel all over the country and thus to verify, on the spot, so far as that was possible, the numerous accounts of early volcanic eruptions and make his own observations of the various volcanic phenomena. It is a most thorough and scholarly work that he has given us. The author finished it in 1912 and, although he lived for nine years more, did not add anything to the manuscript, which is printed here as it was left by him; thus there are not mentioned eruptions like those of Hekla in 1913 and of Katla in 1918. Most of this material, has, of course, been published before in various ways, but it is here for the first time gathered all together between the covers of one volume.

During his travels the author found 130 postglacial volcanoes or places of eruptions in Iceland, by far the most numerous of which were volcanic fissures and crater rows. It has been generally considered that about 30 of these volcanoes have been active during historic times, which cover the last ten centuries; in the author's opinion, it is absolutely certain that at least 23 have been active. Of these, seven are conical volcanoes, eleven volcanic fissures, three or four explosive craters, two or three craters covered by snow or ice, and three or four submarine volcanoes. Ten of the volcanoes have had more than one eruption. Recorded eruptions number 138, some of which the author considers doubtful, while presumably a great many have remained unrecorded. The record is most reliable for the eighteenth and nineteenth centuries and gives 36 eruptions for each of these two centuries; hence it seems plausible to the author to assume that 30–40 eruptions have taken place on the average during each century. Hekla has had 21 eruptions (some of these from craters in the neighborhood of the mountain); Katla, 13; Eldeyjar (off Reykjanes), 10 or 12; but by far most numerous are those taking place in Vatnajökull, that is 38–40; and probably most of them from the same place near Hágöngur. Not very far from this is the Laki crater row where the largest of all the eruptions on record occurred in 1783, pouring forth from some hundred craters a lava field of about 565 square kilometers, probably the largest lava stream on the surface of the earth produced within historical times during a single eruption. The final chapter on the connection between the activities of the Icelandic volcanoes is of particular interest.

The work contains, however, more than the title indicates. The second section (pp. 264–379) gives a long description of hot springs in Iceland, their physico-geological condition and geographical distribution. Of alkaline springs there are known about 677 in 162 different localities; most of them are found in large groups, numbering, according to the author, about 65; comparatively few are isolated, and about half a hundred have not been investigated. Numerous sulphur springs are also to be found, chiefly in the southwestern and northeastern parts of the country; these formerly yielded much sulphur for the market. Carbonic acid springs, called in Icelandic (*ölkeldur*) "ale wells," are especially met with on Snæfellsnes, but they have never been used for any practical purpose.

The third and last section (pp. 380–458) deals with earthquakes in Iceland from 1013 to 1908, giving a list of all on record and whatever information could be gathered about them. The earthquake of 1896 is treated of at great length; this was one of the most severe in recent times and one that caused much damage.

Dr. Mohr's book has the subtitle, "Chat from the Polar Circle"; and chat indeed it is, though not of the interesting kind. Although the author apparently stayed in Iceland for a year or more, his knowledge and understanding of men and matters there are most superficial. He is apparently a journalist (he refers, at least, to himself as "Federvieh"), who makes disastrous attempts at writing humorously. He does not really mean to write in an unfriendly spirit, and yet the book on the whole leaves a bad impression; besides, he has the presumption to write whole chapters on subjects which he has no qualifications to write about, like the Icelandic language and geology. And he advances all kinds of new theories, such as that regarding the origin of the name of the country. He dismisses as unreliable the tale about this to be found in the *Landnámabók*, and positively asserts that the name is to be traced to the big glaciers in the southeastern part which are first sighted when one approaches the country from the southeast. It requires but little acquaintance with the language and with Icelandic place names to see that in such case the name would have been "Glacierland" and not Iceland. But it is useless to enter upon any detailed criticism of such a work. The only redeeming feature of it is the pictures, principally from photographs, some of which have been published before; most interesting, however, are the five colored reproductions of paintings by the Icelandic painter, Ásgrímur Jónsson.

Of a different kind is H. Erkes' article. He has made many trips to Iceland especially with the view of exploring some little-known parts of the interior, to the geography of which he has made valuable contributions; from time to time he has published accounts of these trips in various German periodicals. The present article deals with his journey in 1924 across the country over the route of Sprengisandur and his visit to some out-of-the-way places there (Illugaver and Nýidalur), all of which he describes most minutely. He intended to ascend Vindheimajökull in the north but was prevented from so doing by bad weather; instead he gives a most detailed description of the surroundings of this glacier. An eighth journey made in 1926 is described in a recent number of *Petermanns Mitteilungen* (Vol. 73, 1927, pp. 159–161.)

The directors of the National Bank of Iceland, which began operations on July 1, 1886, have had the happy thought of celebrating its fortieth anniversary by publishing a little manual on Iceland under the editorship of Mr. Thorsteinsson, director of the Statistical Bureau of Iceland. Although a volume of less than 200 pages, its gives much information about Icelandic conditions. It includes articles by various writers on the geography of the country, population, constitution and law, state and municipal finance, agriculture, fisheries, handicrafts and industry, trade, financial institutions, money, weights and measures, communications, social conditions, church and religion, education, literature, fine arts, foreigners in Iceland, Iceland for tourists, etc. In spite of the fact that all this is in a summary form, it gives a good idea of the progress made by Iceland since the constitution was granted in 1874 and in the first few years of its political independence. There are many tasks to be shouldered by a nation of one hundred thousand inhabiting a country of over a hundred thousand square kilometers; and so far the Icelanders have faced them squarely. Down to 1874 they lived under the paternal government of the Danish kings, who did but little to improve their condition or develop the country. To mention one example, hardly a foot of real roads had been built by the government down to that date, and people were still traveling by bridle paths as in the saga times. There were no coastwise sailings, and a single mail steamer made a few trips annually between the government and the governed. Great changes have been made. Roads and bridges have been built in all the most populous parts of the country, although there are as yet no railroads. Three steamship lines, one of them Icelandic, maintain connection with foreign countries, while coastwise sailings are frequent. Most noticeable has been the development of the fisheries, which now are carried on largely by steam trawlers and motor boats—the fish export for 1923 amounted to 37,000,000 Icelandic crowns. Agriculture has not progressed in the same proportion, although advancement also is noticeable there, and great irrigation plans are under way. Little has as yet been done to utilize the immense water power of the country, but this will doubtless be done in the near future. The financial situation is better than in many other countries, the national debt amounting to about 16,000,000 crowns, 10,000,000 of which are external loans. There are two banks in the country and 50 savings banks, the total capital of the latter having increased from 1,363,000 crowns in 1911 to 7,319,000 crowns in 1923. To any one interested in Iceland or Icelandic affairs this little volume can be recommended. Unfortunately it has no map of the country—an omission that should be remedied in a new and enlarged edition.

Halldór Hermannsson

Rural Settlement in Belgium

M. A. Lefèvre. **L'habitat rural en Belgique: Étude de géographie humaine.** vi and 306 pp.; maps, diagrs., ills., bibliogr. H. Vaillant-Carmanne, Liége, 1926.

This interesting and richly and carefully illustrated work is probably one of the first of its kind. It first devotes some 72 pages to the types of distribution of rural houses, next it takes forms of villages and their typical sites, next the density of rural houses and its cartographical representation, as well as the representation of historical changes of that density as far as they can be ascertained. Almost 130 pages are given to a most valuable regional survey of the types and features of houses and farm buildings. There is a long and serious bibliography. The comprehensive character of the work is thus very obvious. Miss Lefèvre has learnt well from her teachers, Professors Michotte and Demangeon. Three large folder maps are added; one gives the region of dispersion of houses as contrasted with the region of their agglomeration and marks hamlets, roadside villages, industrial agglomerates, indefinite villages, etc., in their main regions; the next gives a map of the densities of rural houses; and the last distinguishes various kinds of houses and farm buildings and gives their distributions. Such a study is of special value in a land of historic culture as, unless men are very much alive to the features of their heritage, much is only too likely to be swept away by the influences arising from the dominance of mass production. The study of houses and of forms of settlements has great interest for the humanist, as they are often clues to natural tendencies; they are features that have grown up and are often by no means the result of mere deliberation. Miss Lefèvre's work on houses needs to be imitated and extended in other regions. Her view is that the "Gewanndorf," or village with common fields and strips, is a post-Roman and post-Salian introduction; and thus she goes even farther than Meitzen. When, however, we reflect on the distribution of prehistoric finds and their hints of ancient settlement such a late origin of rural communities seems difficult to accept fully, though it is very likely that the village system underwent considerable changes after the days of the Roman Empire. The subject is a difficult one, and we praise Miss Lefèvre's effort to mark out proper lines of investigation.

H. J. FLEURE

A SUMMARY ACCOUNT OF ASIATIC ETHNOGRAPHY

L. H. DUDLEY BUXTON. **The Peoples of Asia.** xiii and 271 pp.; ills., bibliogr., indexes. (Series: The History of Civilization.) Kegan Paul, Trench, Trubner & Co., Ltd., London; Alfred A. Knopf, New York, 1925. 12s. 6d. 9½ x 6½ inches.

This book by Professor Buxton on the ethnography of Asia embodies the latest available material and is well and interestingly written. It forms one of the volumes devoted to Historical Ethnology in the "History of Civilization" series, edited by Professor C. K. Ogden, of Magdalene College, Cambridge, and, like its companion volumes, possesses a very attractive make-up. Beyond doubt it is one of the most important works in the field of human geography that has appeared for some time.

In the opening chapter there is a somewhat full discussion of the work of the Biometric school. The author justly attaches much importance to its methods, although he is perhaps inclined to overestimate the value of purely mathematical processes. In this connection he might perhaps have made more of the fact that "pure" races in the strict sense have never existed. The evidences of racial mixture go back at least as far as the Upper Paleolithic. The second chapter, devoted to an enumeration and description of the races of Asia, lists five human types as occurring in that continent: (*a*) the Nordic, (*b*) various groups of the "Brown," or Mediterranean, race, (*c*) certain subraces akin to the Alpine stock of central Europe, (*d*) the great group of Yellow Men, and (*e*) the Negritos, with a small number of isolated tribes living in southeastern tropical Asia. The question of the origin of the Asiatic races, discussed in the third chapter, could not of course be entirely ignored; but, as our author himself shows, it is impossible in the present state of our knowledge to reach definite conclusions.

Chapter IV treats of western Asia. In it the author shows that two main races of man occur there, the Mediterranean and the Armenoid, and that such things as an "Arab" or a "Semitic" type do not exist. The following chapter, on India, is one of the longest and best in the book and bears striking witness to the greater fullness of our knowledge of that part of the continent; the discussion of that group of sociological factors comprised under the term "caste" is especially well handled. In the next chapter, however, that dealing with China, Professor Buxton is on less certain ground and quite properly treads more softly. He points out (p. 159) that although the various groups classified under the name "Chinese" belong overwhelmingly to the Yellow races, the term is not to be associated with any physical type but is cultural and linguistic. With one of our author's suggestions, to the effect that traces of the "Brown," or Mediterranean, race exist in China and that it reached that country from the south, most students will probably disagree, as indeed some have already done. The chapter concludes with a conservative summing up of Chinese ethnic strains and a fair admission of the insufficiency of our knowledge.

Chapters VII and VIII, entitled respectively "The Fringed Lands of China" and "Arctic Asia," give good summaries of the little that we know about those regions. The ninth chapter, on Japan, is naturally far more satisfying. The work of recent investigators, particularly Japanese, is discussed at length. Among other points of interest, the author notes (p. 219) a resemblance in physical type between one element of the Japanese people and some of the hill tribes of southeastern China. He might here reinforce his argument with historical and cultural evidences. Ancient Chinese writers tell us that the people of Wo (southwestern Japan) have customs like those of the inhabitants of Wu, the old non-Chinese feudal kingdom embracing the Yangtze embouchure region. And the basic culture of historical Japan, especially its technique of rice growing, is merely a slightly archaic form of that which has flourished in the great central basin of China from time immemorial.

In Chapter X Professor Buxton describes southeastern Asia and Indonesia. In his usual clear and vivid style he gives here (pp. 222 *et seq.*) an excellent picture of jungle and river life and their effects on mankind. These are exceedingly important. For identical conditions of existence must have prevailed over the entire monsoon belt, from western India to eastern China, throughout the human period, until the introduction of metal three or four thousand years ago first enabled men to master and clear away the forest growths. Unfortunately no authority is given for the statement (p. 225) that Sumatra may have been joined to Malacca as late as the second century of our era. If this were true, it would go far toward explaining the late introduction of sailing craft into Far Eastern waters, where they seem first to appear only about that time.

In the "Summary and Conclusions," forming the eleventh and final chapter, the author points out that a considerable immigration of Europeans into Asia has taken place in recent years, with a "corresponding immigration [*sic*] of Asiatics out of their own continent." Possibly the drift of population from European Russia into Siberia may counterbalance that from southern Asia and particularly China to other parts of the world; dependable figures for the former movement are not available. Leaving Russia out of the picture, however, the migration out of Asia is incomparably greater than that into it and would be greater still but for artificial legislative barriers. It has probably been going on since prehistoric times and is one of the most significant facts in the history of mankind.

The bibliography is fairly comprehensive but would be improved if specific page references were more generally given. The indexing is on the whole complete; but here again there is a certain lack of definiteness. The eight plates of Asiatic racial types are decorative rather than truly illustrative. A serious defect in a book dealing specifically with human geography is the total absence of maps, in the text or elsewhere. The faults in Professor Buxton's book, however, are trivial in comparison with its merits, for it is a careful and painstaking account, based both upon personal observation and upon unusually extensive study. An understanding of the racial history of Asia is the key to the whole history of mankind. In helping us to achieve this understanding, "The Peoples of Asia" performs a really important service. A new edition, a few years hence, to keep us abreast of the progress of the investigations now going on, will be most welcome.

C. W. Bishop

Geography of World Trade

Joseph Partsch. **Geographie des Welthandels.** 358 pp.; index. Ferdinand Hirt, Breslau, 1927. Rm. 22. 9½ x 7 inches.

The late Dr. Partsch, a clear thinker and thorough research worker, Ratzel's worthy successor, passed away before he could complete this last work. Thanks to former students and friends, the editing and publication of the manuscript has been made possible, and in consequence an important contribution to the field of geography has been effected.

Partsch was always a pioneer, but his modesty retarded a full appreciation of his work by his contemporaries. Just as he was one of the first geographers to recognize the value of a regional treatment of his science, well developed in his "Central Europe," still a standard work, so in his "Geographie des Welthandels" he blazes a trail by his departure from the method of treatment that characterizes most of the commercial or economic geography texts.

Partsch intended to treat the subject in three parts, of which two appear in this volume, namely (1) the varying conditions under which man lives upon the earth and which give rise to exchanges and (2) the distribution of the world's goods which enter into world trade. The third part was planned to include a consideration of the means of distribution and of trade centers. In Part I density of population, races, language, religion, and political organization are treated, groups of facts being presented first under the respective headings followed by a statement of the geographic significance of the group in the world's trade. Under Part II the distribution of the world's goods is presented regionally according to place of origin and subsequent development in other parts of the world. On this basis, treatment of plant and animal products of the land occurs by climatic regions, while products derived from the seas are discussed under a division of the seas largely climatic in character. Minerals receive attention in a special section. This treatment represents a distinct departure from that to which we have been accustomed. For example, American cotton production and trade are treated under "Products of the Monsoon Regions in Southern and Eastern Asia," while tobacco finds a place under the subdivision, "Summer Drouth, Subtropical Region." On the other hand, cane sugar is discussed under the heading "The North Temperate Zone as a Primary Center for Agricultural Activities." It is introduced here because the sugar beet has been a critical factor in European life, beet sugar having not only had to face competition with cane sugar, but having been confronted with the problem of maintaining itself upon the world's markets.

Partsch never loses sight of his viewpoint. He consistently keeps commodities in motion and quite as logically reduces economic discussion to a minimum, introducing it only as an incident to the movement of products. Likewise he recognizes the non-geographic influences in trade such as coinage, the telegraph, trade politics, and tariffs, remarking as follows about the last item: "It is surprising how generally handbooks of commercial geography entirely omit mention of tariffs" (p. 67).

Unfortunately the third part, on trade routes and trade centers, which Dr. Partsch planned to include, has been omitted; but there is hope that this may yet appear as a unit volume. It constituted a phase of geography which, in recent years, appealed strongly to the author.

Eugene Van Cleef

AN INDUSTRIAL MAP OF THE WORLD

OLOF JONASSON. **Näringskarta över Jorden.** Scale 1:20,000,000. 4 sheets. Generalstabens Litografiska Anstalt, Stockholm, 1926. Kr. 23.

Näringskarta is a colored wall map on the Mollweide equal-area projection with four colored insert maps of the world on the same projection (equatorial scale, 1:80,000,000). These show (1) temperature data and mean annual precipitation, (2) topography, (3) natural vegetation and ocean currents, and (4) the commercial languages of the world and the origin and movement of Swedish foreign trade. The wealth of detail in the principal map marks it as a scholarly production, the value of which is enhanced by well chosen colors and beautiful lithography.

Although the principal map carries some facts relating to climatic conditions, ocean trade, and the distribution of the manufacturing industries, it is primarily a map of the use of land—agricultural, pastoral, and forestal. This difficult and complicated subject is handled in a manner pleasing to the eye by a method that appears, on first sight, relatively simple. The plan involves the subdivision of the land of the earth into five major types of regions on a basis of use, each of which is distinguished by a general underprint in one color. The types of regions are (1) agricultural, or temperate, regions (yellow); (2) subtropical fruit, or Mediterranean, regions (green); (3) plantation, or tropical, regions (blue); (4) rice, or monsoon, regions (red); and (5) unproductive regions (gray). These colors are superimposed upon a base with coast and rivers in deep blue and unobtrusive topographic shading in dark gray. That the broad generalization of this classification is sometimes too sweeping is seen in the fact that the subtropical fruit, or Mediterranean, region is made to include, in addition to the regions of truly Mediterranean climatic type, nearly all of eastern South America from Santos to Cape Horn.

Subdivision of these major regions is accomplished by means of shades or tints of the principal color or by overprints. One can but admire the skill with which this is done, for there are in all thirty-nine color and symbol combinations. Yet there is no confusion, and the general effect is harmonious. The interpretation of these combinations is, however, a different matter. Not only are many of the unit areas too small to be seen clearly at classroom distance, but they have not always identical significance. Thus: in the temperate region a deep orange yellow signifies, for Europe, the region in which wheat, vines, and sugar beets are the principal products and marks approximately the northern limit of the vine. For North America, the same color signifies a region in which the principal products are tobacco, wheat, and maize and marks approximately the northern limit of plantation agriculture. One of the tropical blue combinations has three different, although similar, meanings in the three continents in which it appears. Some colors have one significance only.

These complications are perfectly intelligible upon close inspection, but they greatly decrease the usefulness of a wall map. Indeed, it is the feeling of the writer that Dr. Jonasson's excellent map will find principal use in American classrooms as an object of close laboratory study by individual students. For that use its present form is not convenient.

V. C. FINCH

A HISTORY OF SEISMOLOGY

CHARLES DAVISON. **The Founders of Seismology.** x and 240 pp.; maps, diagrs., index. The University Press, Cambridge; The Macmillan Co., New York, 1927. $4.25. 8½ x 6 inches.

Davison considers that seismology as a science was founded when investigators broke loose from the speculations of the ancients and based their conclusions on contemporary observations. He fixes this time as the middle of the eighteenth century, when the important but little known account of the Lisbon earthquake of 1755 by John Michell was published. After a preliminary chapter on some earlier writers he devotes special chapters to John Michell, Alexis Perrey, Robert Mallet, Fernand de Montessus de Ballore, John Milne, and Fusakichi Omori. There are chapters also on the study of earthquakes in Italy, in Central Europe, and in the United States. Though naturally confining his attention to those whose life work is ended, he makes some reference to living students in the last three chapters mentioned.

Davison begins his account of each investigator with a short biography, then analyzes his work with full references to the places of publication, and finally gives his estimate of its value. This method emphasizes the fact that all our knowledge is due to the work of individuals and does not simply grow of itself.

It is interesting to note how early some ideas, still current, originated. Michell, for instance, clearly recognized that earthquake motion was propagated as elastic vibrations; and he described the method of finding the epicenter by the direction of the motion, a method later developed by Mallet. He also showed how to find the distance of the origin of some submarine earthquakes by the difference in time of arrival of the shock and the sea wave. Again, the Italians recognized the influence of the terrain on the destructive effects of a shock more than a hundred years ago. It is curious to note how closely the work of de Montessus de Ballore paralleled that of Perrey. Each devoted his life to the making of a great catalogue of earthquakes and used it to test laws of periodicity and as a basis for regional memoirs. But de Montessus went further and connected the earthquakes with the geology and topography of the region.

The book is an interesting and valuable addition to seismological literature. Seismologists may differ somewhat with Davison as to the relative values of the various investigations recorded, but this is a matter of personal opinion. It will add to the interest of the book and will not detract from its value.

HARRY FIELDING REID

POSTGLACIAL MOVEMENTS IN GREENLAND AND SPITSBERGEN

THOROLF VOGT. **Bretrykk-teori og jordskorpe-bevegelser i arktiske trakter i ny tid (The Theory of Ice Pressure and Movements of the Earth's Crust in Arctic Regions in Modern Times).** *Norsk Geogr. Tidsskr.*, Vol. 1, 1927, No. 6–7, pp. 336–386.

The west coast of Greenland and the Thule District, or the region north of Melville Bay, are undergoing submergence. This is primarily shown by drowning of ruins of houses built by Eskimos, by Northmen during their colonization between 982 and the sixteenth century, and by Danish settlers since 1721. The submergence at Godhavn amounted to 15 centimeters between 1897 and 1923, i. e. in 26 years. The rate is thus 58 centimeters in one hundred years. Whether East Greenland is being submerged or not is yet unknown.

Spitsbergen, according to A. E. Nordenskiöld, is rising, and according to other authors is stationary. Vogt, however, finds several contrary lines of evidence. Many ruins of winter huts built by Russian hunters and trappers between about 1715 and 1850 lie remarkably low; one even is reached by the waves. The sea cliffs, the interior of the fiords, the submarine shelves lining the fiord walls, and drowned valleys, suggest transgression; while the great difference between the modern molluscan fauna in Ice Fjord and the subfossil fauna even of very low raised shell beds indicates either a long standstill at the present level or submergence in recent and modern times.

None of the conditions mentioned affords certain evidence of submergence in Spitsbergen, but they make this highly probable. In Jan Mayen, Bear Island, and Novaya Zemlya the shore line may either be stationary or rising.

Modern transgression in Greenland and Spitsbergen is believed by Vogt to be due to depression of the land by growth of the ice sheets since the postglacial temperature maximum which according to records in Sweden prevailed from about 7000 to 3500 or 2500 years ago and according to archeological records in central Europe ended about 850 B. C., or 2775 years ago. At the time of the temperature maximum the glaciers in both Greenland and Spitsbergen had less extent and thickness than today. However, if they were smaller the sea level then stood higher than today. Subsequently, as the glaciers grew, both the sea and the land sank. To the apparent sinking of the land, the amount of transgression, should therefore be added the amount of the lowering of the sea level. If this latter since the temperature maximum is 5 meters, as R. A. Daly now thinks, the actual recent sinking of Spitsbergen amounts to some 11 meters, not 6 meters, as Vogt states.

ERNST ANTEVS

SOME STUDIES IN PLEISTOCENE GLACIATION

PAUL KESSLER. **Das eiszeitliche Klima und seine geologischen Wirkungen im nicht vereisten Gebiet.** 210 pp.; maps, diagrs., ills., indexes. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 1925. 13 M. 9½ x 6½ inches.

HERBERT LOUIS. **Die Verbreitung von Glazialformen im Westen der Vereinigten Staaten.** *Zeitschr. für Geomorphologie,* Vol. 2, 1927, pp. 221–235.

PAUL BECK. **Eine Karte der letzten Vergletscherung der Schweizeralpen.** 53 pp.; maps, diagrs., bibliogr. (Naturw. Gesell. Thun, Mitt. 1.) Geographischer Karten-Verlag Bern, Kümmerly & Frey, 1926. 9 x 6 inches.

The climatic modifications during the glacial epochs, affecting practically the whole globe, were especially pronounced in the proximity of the ice sheets, for instance in the region between the North European ice and the expanded glaciers in the Alps, the region treated in the first mentioned paper.

The lines of evidence employed in the study are the present climate about the existing ice sheets, fauna and flora, and geological phenomena, the last including frost weathering, solifluction, loess which is held to be glacial in age, cirques, height of the snow line, etc. The temperature is found to have been about the same in the whole region between the two glaciers during their greatest extent. There was no distinct differentiation of tundra, steppe, and forest climate. The mean annual temperature amounted at most to –2° C. but was probably lower. The winter temperatures were very low, the summer temperatures rather high. The daily temperature variations were large and emphasized by the cold dry northeast winds sweeping down from the ice. Annual precipitation was insignificant, but torrential evaporation was very great. The snow line during the last climax lay at some 1000 meters in the Alps, at 900 meters in the southern Schwarzwald, and at 850 meters in the northern Schwarzwald, whence it rose northward, suggesting decreasing precipitation and increasing evaporation.

This volume, by the late professor of geology in the University of Tübingen, is an interesting and important study with a wealth of material.

Louis's paper, based on a study of American literature and topographical maps, treats the extent of Pleistocene glaciation in the mountains of the western United States, distinguishes the type of glaciation, viz. hanging glaciers, valley glaciers, and "net" glaciers, and demonstrates the main features on a map. The approximate snow line has also been determined. It shows that the glaciation was determined by topography and direction of the predominating winds, and also that the rain-bringing winds came from the west then as they do today.

Beck's paper summarizes our knowledge of Pleistocene glaciation in Switzerland. His main map attempts to show the extent of the greatest and of the last glaciations in Switzerland and adjacent regions and the contemporaneous position of the ends of the glaciers when the snow line lay 200, 400, 600, 800, 1000, and 1200 meters lower than today. Another map shows the height of the present snow line. The relative rôles of ice erosion and river erosion are discussed and found to be about equal. The influence of the glaciation on drainage, etc. is also treated.

Ernst Antevs

Tropical Cyclones

I. M. Cline. **Tropical Cyclones.** xii and 301 pp.; maps, diagrs., bibliogr., index. The Macmillan Co., New York, 1926. $5.00. 9 x 6 inches.

The author has spent a lifetime in the study of the climate of the Gulf States and, as official forecaster in the U. S. Weather Bureau, has acquired an unusual amount of intimate knowledge of storms which have crossed the Gulf of Mexico and the Gulf States since 1900.

A large amount of original material pertaining to pressure, precipitation, winds, and clouds in their relation to the center of tropical cyclones is presented in convenient tabular form for further study by students of meteorology.

In plotting the records of all tropical cyclones which have crossed the area since 1900, Dr. Cline has employed a method of his own to show the hourly values for rainfall, wind, and clouds in their relation to the barometric center of the advancing storm. Superior merit is claimed for this method, and it doubtless enables one to present essential elements and their relationships in less space than is possible by means of synoptic weather charts; on the other hand the method does not show the distribution of wind and rainfall in connection with the vital factor of the prevailing pressure system, with which precipitation and wind direction and velocity are intimately connected. Students of meteorology will miss the familiar synoptic chart.

The author finds that: (1) The area of excessive rainfall in storms within the area studied is in front of and to the right of the center of the advancing storm. (2) Very little precipitation occurs after the center of the storm has passed. (3) The area of lowest pressure moves towards the region of greatest precipitation. (4) There is no radial outflow of cirrus clouds from the center of the cyclone, as has been maintained by well known authorities. (5) Air currents a mile or more above the earth's surface in the region of the rain clouds largely determine the direction towards which the cyclonic area advances. (6) Hurricanes seldom travel along straight lines.

Dr. Cline's investigation of tropical hurricanes is confined to storms within the Gulf of Mexico and the Gulf States—a region mostly within the area of recurve of hurricane tracks. In this area the storms are passing from a region in which the general air movement is from east to west, into a region of drift from west to east. Generalizations based upon the behavior of storms in the recurve may not, however, hold good in the first and third branches of the usual parabolic path—i. e. during the greater part of the life of the storm.

In the vicinity of Porto Rico and the Lesser Antilles, i. e. in the long first branch of the path of the cyclone, the distribution of rainfall is more nearly about the center, while the area of greatest intensity of precipitation is more likely to be behind than in advance of the barometric center; hence the area of excessive precipitation cannot here be a determining factor in the progressive movement of the storm.

Observations of cirrus clouds and pilot balloons at San Juan, Porto Rico, are in accord with Dr. Cline's statement that there is no radial outflow from the center of the cyclone in the cirrus level and that cyclones are carried along in the general drift of the atmosphere in the locality. In the vicinity of the Lesser Antilles and Porto Rico the usual direction of movement of cyclones is toward the west-northwest, which is the prevailing wind direction over Porto Rico throughout the hurricane season at an elevation of about 10,000 feet.

The statement that cyclones seldom travel along straight lines, while applicable to the area of recurve, does not hold good in the long first and third branches of the paths where storms travel in approximately straight lines for a thousand or more miles.

In an appendix Dr. Cline has added an interesting and valuable contribution on the relation of changes in storm tides on the coast of the Gulf of Mexico to the center and movement of hurricanes. The author finds that the waves and swells of the greatest size and length are developed in the right-hand rear quadrant of the cyclonic area, where the winds are strongest and of greatest duration in the direction of advance of the storm.

Very little light can be brought to bear upon the problem of the origin of tropical cyclones by a study of surface conditions in the Gulf region or in the region of the West Indies. Most of our storms have their origin over the Atlantic between the African coast and the West Indies and reach the Antilles fully developed. Moreover, these storms most probably have their origin in opposing currents within the region of the intermediate clouds at elevations of 10,000 to 15,000 feet and seem to be intimately associated with the increasing depth and strength of the easterly trade winds with the advance of the hurricane season. The normal depth of these winds during the hurricane season in the vicinity of Porto Rico is about 20,000 feet. The change to westerly winds above the trades is generally abrupt. Such a situation is favorable for the formation of cyclonic disturbances on a very large scale. The prevailing westerly winds may descend from an elevation of 20,000 feet to the earth's surface within less than 24 hours, while the displaced easterly trades may pile up to elevations of 25,000 to 30,000 feet within the same short period.

These rapid fluctuations are generally accompanied by heavy rains and stormy conditions. Pilot balloon observations over the breeding ground of hurricanes would be of the greatest value in the solution of the problem of the origin of cyclones.

OLIVER L. FASSIG

THE RAINFALL OF SOUTH AFRICA

A. D. LEWIS. **Rainfall Normals up to the End of 1925.** With an Introduction and Brief Summary of the Rainfall of the Union of South Africa. xiii, 109, and xxii pp.; maps. Union of South Africa, Dept. of Irrigation, Meteorol. Office, Cape Town, 1927. 13 x 8½ inches.

When it is realized that over 58 per cent of the Union of South Africa has a rainfall of less than 20 inches and that nearly 73 per cent has less than 25 inches there is no need to enlarge on the importance of this publication. The text includes tables of average monthly and yearly rainfall at all the stations of the Union and a key map and 31 sectional maps on a scale of approximately 20 miles to the inch showing location of the stations and hyetal lines 5 inches apart. There are three separate maps of Africa south of latitude 22° S. on a scale of 40 miles to the inch. One in 11 tints shows average annual rainfall; the second gives graphs of annual rainfall over a period of years for 31 selected stations; the third is a "clock" map similar to that designed by Mr. Lewis for his report on the development of water resources in Kenya (see p. 155 of this *Review*): the monthly distribution is represented by sectors of circles whose radii are proportional to the amount of rainfall.

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